THURSDAY, APRIL 2, 1896.

THE HISTORY AND MANUFACTURE OF EXPLOSIVES.

Geschichte der Explosivstoffe. Von S. J. von Romocki. Two parts, pp. 394 and 324. (Berlin: Robert Oppenheim, 1895, 1896.)

The Manufacture of Explosives. By Oscar Guttmann, A.M.I.C.E., F.I.C. Two volumes, pp. 348 and 444. (London: Whittaker and Co., 1895.)

THE first part of the first of these two works is a most curious compilation, drawn from all sources, of historical matter connected with the manufacture and different uses of explosives. The author appears to have spared no trouble in hunting up old documents and engravings illustrating the different engines of war, which have depended on villainous saltpetre for part, at least, of their destructive attributes. These engravings are extremely quaint, and give one a good idea of the state of mediæval art as applied to printing; that shown on pp. 288-289 ("Verteidigung eines Engpasses mit Landtorpedos") depicts a most theatrical ambuscade in which the "special artist" has surpassed himself, and the enemy thoroughly deserve the destruction which has overtaken them. Naturally most of the text is German, but there is also a large amount of French and Latin intermixed, here and there, with a little Greek and Arabic, or even Chinese, and one can only regret that the exigencies of modern life prevent most people from acquiring even a very superficial knowledge of the numerous and varied tongues with which the gifted author appears to possess so great a familiarity.

In part ii. the author continues the narrative in dealing with the various natures of ordinary and the more modern descriptions of gunpowder, and includes much interesting matter relating to the production of chlorates, nitrates and picrates, and to the history of the discovery of guncotton by Schönbein, as well as of the subsequent prolonged attempts in Austria to utilise it in guns as a smokeless propellant. These attempts proved futile, and ended finally in the idea being abandoned, though not before several accidents had taken place. The manufacture of the several explosives is dealt with to some extent, but apparently simply with a view to including them in the historical records of the various patents which covered their invention.

As an interesting statement of historical facts connected with gunpowder, these volumes leave little to be desired; but the reader will find no new data regarding the results, ballistic or chemical, of the new powders, nor are the given results of the older powders so complete as to render the work really valuable to the student.

Mr. Oscar Guttmann's work on explosives is of quite a different type, and makes no pretence whatever to dilettanteism; on the contrary, everything is described in an eminently practical way, with the intention of interesting only those who are concerned in the manufacture or use of explosives. To the military and to civilians the work is strongly recommended, as it is practically the only trustworthy one on the manufacture of modern explosives in the English language, and as it consists of a most careful and extensive selection of the experience gathered by manufacturers of explosive material, or of the allied substances necessary in the manufacture of explosives.

The historical prelude, which has now become an inseparable portion of all technical works, is brought within reasonable limits and occupies about 22 pages, of which 17 are employed on speculations regarding the origin of gunpowder; but no very convincing conclusions are arrived at, except that, perhaps, the honour of the invention of guns—not gunpowder—belongs to Berthold Schwarz, a Freiburg monk. In England it is our conceit to consider Roger Bacon, also a monk, as the inventor of gunpowder. This, however, is very problematical, but the curious fact remains that the clerical profession have always taken a deep interest in the improvement of engines for the destruction of human life; we may instance the two monks aforesaid—without mentioning the many bishops who, in mediæval times, themselves wielded the mace on the battle-field; then we have the inventor of percussion-caps and more lately we have two clergymen, each distinguished as the inventor of a ballistic instrument, and to one of whom the art of gunnery owes a deep debt of gratitude.

The preparation of the prime materials are dealt with mostly in volume i., and include the more important substances necessary in the production of ordinary black powder, and, what is far more interesting, of the new smokeless powders. The production of glycerine and nitric acid are fully dealt with; but for sulphuric acid the author modestly refers the reader to Lunge's work. The preparation of charcoal is treated exhaustively, with the exception of that particular variety used in the manufacture of brown powder, the exact treatment of which is kept a secret; and it may be for the same reason that brown powder itself is not dealt with. This is, however, of small moment, as the use of ordinary gunpowder, of both black and brown varieties, is becoming very restricted as propellants, and even in mining operations black powder is being gradually ousted in favour of the so-called flameless explosives.

The important point of blending is dealt with only so far as this operation is performed by mechanical means—*i.e.* for small grain powders; but in the manufacture of prismatic powders, slight variations of density are unavoidable in different batches of prisms, and blending by hand has to be resorted to. Similarly with smokeless powders, it is found that different lots of cotton give rise to some slight variations in the guncotton produced, which, although of a trifling nature, are quite sufficient to affect the ballistics of the resulting powder; so that such powders as cordite or ballistite in sticks or tubes require to be hand-blended.

Volume ii. is a most interesting and valuable addition to the literature on explosives: the manufacture of nitrocellulose—both the true guncotton and collodion-cotton varieties—is described fairly completely, and, although apparently so simple, there are certain difficulties of an economical nature in connection with the production of collodion-cotton having a definite degree of nitration. The production of nitro-glycerine receives the attention

which this dangerous substance deserves, and manufacturers and users of it will find much valuable information regarding precautionary measures in dealing with this explosive or with the dynamites, of which it forms practically the only explosive ingredient. But neither guncotton nor dynamite would be of much service without the detonator, which consists of a copper capsule filled with that curious substance, fulminate of mercury. The production of this material is briefly described, and an attempt is made to elucidate its chemical constitution; the subsequent charging of caps and detonators is dealt with at greater length. In connection with the late terrible explosion of dynamite at Johannesburg, it is stated that the detonators and dynamite were carried in the same railway truck; and if this really were so, no surer means of producing an "accidental" explosion could have been devised.

Users of the so-called safety explosives—ammonite, bellite, &c.—will be interested in tracing the preparation of the different ingredients, the principal of which is generally one of the nitro-compounds of benzene.

The subject of smokeless powders is treated well, and the different machines used are illustrated in such a manner as to show their general construction and essential parts. The manufacture of cordite, as carried out at the Government factory at Waltham Abbey, is one of the most interesting, inasmuch as it is the powder adopted by the War Office for use in rifles and in guns of all calibres. The procedure is, however, somewhat varied in private factories, as, for instance, the cordite paste, instead of being mixed by hand, is sometimes mixed more or less mechanically under water, and in consequence handling the paste is to a large extent dispensed with. Handling substances containing nitro-glycerine for the first time frequently produce most distressing symptoms, due to the absorption of the nitro-glycerine by the skin, the operator being seized with violent headache, or often with vomiting; these symptoms, however, rapidly disappear in the course of a day or two. The complexion of those employed is much improved, and on this account there is a great competition for employment among the young women of the district, it being considered a sure road to matrimony.

The last portion of the work is devoted, more or less, to the description of the apparatus used in the examination of explosives; some of the instruments belonging, let us hope, to a bygone age, are of the most crude description, but there are included some of the more refined instruments employed at the present time. Very little, indeed, is said about the results obtained from ordinary powder, or from the modern explosives; and to those who are interested in the new powders as propelling agents, the question of the energy that can be developed by them, and the conditions under which such energy can be efficiently and satisfactorily utilised, is of the highest importance. So far as we know, the most complete and extensive series of experiments on this subject, and on certain kindred researches, has been made in this country principally at Elswick, and some interesting results have been obtained.

Should a new edition of the work be called for, no doubt some of the debatable points would receive revision; and we would also recommend the author not to make the same indiscriminate use of the Centigrade and Fahrenheit thermometric scales which appears in the present edition; both volumes, however, show very conclusively the large amount of engineering skill Mr. Guttmann has brought to bear in their production.

H.

ENTOMOLOGY AND EVOLUTION.

Handbuch der paläarktischen Gross-Schmetterlinge für Forscher und Sammler. Von Dr. M. Standfuss. Pp. xii + 392; eight plates. (Jena: Gustav Fischer, 1896.)

IT has long been recognised that the class of insects is particularly rich in good material for the elucidation of many important biological problems; and in the hands of Bates, Wallace, Meldola, Poulton, Merrifield, Fritz Müller, Weismann and others both in this country and abroad, to say nothing of Darwin himself, the lepidoptera, and especially the butterflies, have been largely turned to account in elaborating the details of the picture of organic evolution. Notwithstanding all that has been done both by way of observation and experiment in this direction, it can hardly be questioned that the author of the book before us is right in asserting that the work of systematic entomologists has not been made so profitable to science as it might have been; and that entomological literature has hitherto been overlooked, with some justice, by scientific zoologists. In re-editing with large additions his former useful "Handbuch für Sammler der europäischen Gross-Schmetterlinge," Dr. Standfuss has proposed to himself the laudable aim of raising the "Cinderella of the Sciences" to a position more worthy of her intrinsic merit; and his method of so doing is to combine a full account of his own experiments and speculations on various points of biological interest with the practical directions of a manual for collectors. The result is the substantial volume before us, which the author hopes will serve as a stimulus to the "mere collector" to direct some of his energies into channels which may lead to really important scientific results. There can be no doubt that Dr. Standfuss has thrown himself into his task with great vigour and enthusiasm. The experiments recorded in this book were conducted on a very large scale, and must have laid a severe tax on the industry and perseverance of their originator. Any one with experience in this direction will have some idea of what is involved in the rearing of more than 7000 lepidopterous larvæ through their various stages, under varying conditions, and in keeping full records of the results. Whether the ordinary collector will be stirred into emulation of these achievements is perhaps doubtful, but Dr. Standfuss has certainly done his best to show him how much interest may attach to the study of butterflies and moths when conducted with a definite scientific object.

The practical part of the book needs little comment. It treats of the usual topics to be found in works of the kind in a plain and serviceable manner. The advice given is sound and sensible, and bears evidence of being the fruit of the author's own experience. We note that

the diseases of larvæ and pupæ are dealt with at greater length than is often the case in similar manuals. With regard to the section on the care of a collection, our own opinion would be in favour of considerably amplifying the suggestions here thrown out as to labelling and register-keeping.

It is, however, to the experimental and speculative part of the work that the scientific reader will turn with most interest. Here he will find a large mass of valuable material; consisting in the chief place of elaborate records of the author's own experiments. The first subjects dealt with are those of hybridisation, the respective influence of the male and female parent on the structure and appearance of the hybrid progeny, the fertility of crosses, the production or suppression of intermediate forms. The value of well-planned and systematic experiments on these points cannot be easily overestimated. The importance of the subject has been fully recognised by Darwin, Wallace, Galton and Weismann amongst others, but the comparative absence of quantitative results such as Dr. Standfuss gives us, and the consequent impossibility of applying any measurement to the forces at work, has hitherto prevented the facts of hybridisation, their relation to fertility, and their bearing on questions of heredity and species-formation, from having their due weight in the discussion of biological problems. Another large and most interesting group of experiments centres round the question of the effect of abnormal external conditions, during the immature stages, upon the form of the perfect insect. The author has here taken as his model the well-known temperature experiments of Dorfmeister, Weismann and W. H. Edwards upon lepidopterous pupæ, elaborating the conditions and extending his investigations over a wider range of material. It is remarkable that the species selected by him as the subjects of experiment were in very many cases the same as those used by Merrifield, who had already been working quite independently on similar lines, and most of whose results, published before those of our author saw the light, are in close agreement with the latter. The work of each experimenter thus receives independent confirmation from that of the other

While there can be no question of the remarkable interest attaching to the effects obtained by these temperature-experiments upon pupæ, and while it will be generally allowed that much gratitude is due to Dr. Standfuss for his assiduity in conducting and recording the large number of experiments here referred to, and in accurately describing their results, there will be much difference of opinion as to the value of his interpretations. Dr. Standfuss's own views on the subject of evolution may be shortly stated. He believes in the hereditary transmissibility of acquired characters; and without enunciating any definite theory of the nature of pangenesis, he argues in favour of a centripetal mode of germ-formation. Variations are, according to him, produced by the direct effect of the environment on the parent organism, and the principle of natural selection is limited in operation, many species having become established without its aid. The theory of mimicry, he thinks, has certainly to be reckoned with, but great caution must be used in applying it to the explanation of any given case. Of Fritz Müller's development of the mimicry theory, in consideration of which many of his objections would lose their force, he takes no notice. From all this it may be seen that our author is a pronounced Neo-Lamarckian Space would not allow us to follow him in all his speculative arguments, which, though often far-fetched and sometimes demonstrably erroneous, are always ingenious and interesting. Recognising the extreme value of facts in reference to such a question as that of the true nature of heredity, we have carefully searched the whole volume for any unequivocal instance of the genuine transmission of an acquired character, and we are bound to say that we have not found one, unless n the sense admitted by Weismann ("The Germ-Plasm," 1893, p. 401), which, strictly speaking, is not a matter of heredity at all. The author has evidently convinced himself that several of his results are to be interpreted in the former, viz. the Lamarckian way. For our own part, we can only say that they seem to us to be all capable of other explanations; and that in spite of the difficulty he alleges (p. 292), the only means of attempting a satisfactory solution of this question, as it appears to us, would be a careful experimental inquiry pursued through several generations. For this purpose some species should be sought for which is at the same time capable of partial domestication, and possesses distinctive features of colour and pattern which are fairly sensitive to external influences. An argument against Dr. Standfuss's view of species-formation is afforded by the curious reversionary character of many of the changes produced by exposure of the pupa to abnormal conditions of temperature. The ancestral features thus revived are sometimes of so very distinct and special a kind, that it seems scarcely adequate to regard them, as he does, simply as the direct effect of temperature conditions similar to those under which the ancestral form came into existence. But our author practically ignores the possible influence of sexual selection and of the necessity for recognition in the production of characteristic external markings, and with him "adaptation" as applied to these markings means little else than protective resemblance. Hence, probably, his limited view of the action of natural selection, and his readiness to attribute the distinct aspects of the various species of *Vanessa* and other groups to direct climatic influences, *plus* isolation. Still, whatever may be the omissions and shortcomings of the book from the theoretical point of view, of which much more could be said, its value as a great quarry of facts is undeniable, and the author makes no attempt to present his experimental results in any but the most fair and impartial manner.

The value of the descriptions is greatly increased by the excellent plates, which are very well executed and really illustrative of the text. The book is well printed; we have only discovered a very few misprints in the text, and one small inaccuracy in one of the plates. The want of a general index is a serious drawback. Taking the work as a whole, we are bound to say that it is one that challenges the serious attention of biologists, and that whatever may be thought of the author's speculations and arguments, the facts that he has collected are of unquestionable interest and importance.

F. A. DIXEY.

A PHILOSOPHY OF MAN.

Die Schöpfung des Menschen und seiner Ideale. Ein Versuch zur Versöhnung Zwischen Religion und Wissenschaft. Von Dr. Wilhelm Haacke. Mit 62 Abbildungen im Text. Pp. x + 487. (Williams and Norgate, 1895.)

AN author who claims for his book that it is, "in its aim and substance, entirely new and original," does not prepossess a reader in his favour; nor do the contents of Dr. Haacke's book remove the prejudice. He seeks to prove that the mechanical conception of nature leaves room for faith in a moral order of nature, by showing that natural bodies and organisms, and human ideals alike follow a great law of tendency to equilibrium. The book is popular in character, and it has the merit of being very readable. It is partly and mainly biological, partly philosophical, and throughout speculative. Dr. Haacke will have nothing to do with Darwin or Prof. Weismann—not merely that he rejects pangenesis or the continuity of the germ-plasm, but natural selection as well. He substitutes an epigenetic theory of *gemmæ* or crystals of the germ-plasm, which have polarity and are united into a *gemmarium* (or collection of *gemmæ*) whose configuration seems to be determined by every influence which affects the organism. The theory, which is explained in full in the author's work "Gestaltung und Vererbung," is based on the assumed transmission of acquired characters. How unclearly he conceives the problem is shown by his description of an ideal test of that transmission (p. 344), which is no test at all, and by the confused treatment of inherited memory. Dr. Haacke thinks that in consequence of the organic connection of every part of the body, acquired characters may affec the configuration of the gemmarium, but he does no explain how the male gemmarium, when it passes rom the parent body, should retain this configuration. The philosophical portion of the book is purely hypothetical. Each atom has sensation, and therefore, according to the sensori-motor law, also motion, which it exhibits in the tendency to equilibrium with other atoms. Schopenhauer's "will to live" is replaced by the "will to equilibrate." It is not clear whether the author supposes each brain-cell to have consciousness (which is psychological atomism with a vengeance). The most interesting portion of the book, from a philosophical point of view, is the slight sketch in which it is shown that art, morality, and religion exhibit the tendency to unite various elements into an equilibrium, that is, in simpler language, into an organic system. It is not, however, quite original, nor is it adequate. The author hopes to reconcile religion with the materialistic conception of nature in half a page, in which he declares the ideal of religion to be the equilibrium of all other ideals, and God to reveal himself everywhere as the tendency to equilibrium. From a purely speculative point of view, the author's doctrine is open to a grave objection. That every organic form which can maintain itself exhibits internal equilibrium is undoubted, and if Dr. Haacke had expounded this truth in its application to morality and knowledge with anything approaching adequacy, he might have done service. But it is quite another thing to assume a "tendency to equilibrium." How much truer is the simple doctrine of Spinoza, that everything tends to "persist in its being"—*in suo esse perseverare*—a real tendency of which equilibrium is the result. Such a view is perfectly compatible with natural selection, which is the process by which bodies that cannot be in equilibrium under their conditions are eliminated. But Dr. Haacke apparently takes natural selection to be a force instead of a mere process according to which forces act, dismisses it for this reason, and sets up in its place an unreal striving after equilibrium, which equilibrium is only an effect. Of his purely philosophical quality the sample which the author gives in the concluding portion of his book does not induce us to recommend the book to the study of philosophers.

OUR BOOK SHELF.

Roads and Pavements in France. By A. P. Rockwell, A.M., Ph.B. Pp. 107. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1896.)

THE title of this book is hardly broad enough to do justice to the contents, which include general descriptions of construction and maintenance of roads, and of other points to be considered when building a new road or improving one already built. At the same time, all who have to do with road-making know that they can learn something from an account of the methods adopted by the highly-educated and able engineers whose work has resulted in the excellent roads of France to-day, and whose experience as to the best and most economical systems extend over more than a hundred years. The author has brought together the results of this instructive experience, and has thereby produced a work which will be of great service to road contractors and engineers in every country.

Single-Salt Analysis. By B. P. Lascelles, M.A. (London: Swan Sonnenschein and Co., Ltd., 1896.)

THIS addition to the already too numerous sets of tables for use in chemical laboratories, consists of fourteen cards containing instructions what to look for, and what to conclude, when conducting the various operations involved in the analysis of a simple salt. Five cards are devoted to stating dry tests, and the remainder are taken up with wet tests for a simple salt, soluble in water or acids. The cards will be useful in elementary chemical laboratories, where test-tubing is the order of the day; but we hope for a time when their use will be limited to students who intend to become analysts, for work conducted upon the lines laid down in these and similar analytical tables are of no educational value whatever

The West Indies and the Spanish Main. By James Rodway. Pp. xxiv + 371. 48 illustrations. (London: Fisher Unwin, 1896.)

THE stirring events described in this latest addition to the "Story of the Nations" series are sufficient to furnish material upon which a score of romances might be built, even though Marryat, Kingsley, Stevenson, and other writers innumerable have made the Indies the arena of all the incidents attractive to adventurous spirits. So full of incident is the history of the West Indian Islands, that Mr. Rodway has had a difficulty in compressing his story within reasonable limits, and he has only been able to do so by giving preference to facts referring to the islands as a whole, and omitting events of interest chiefly to the communities of particular islands and provinces. Little is said about the islands from the scientific point of view, but as a contribution to historical geography the book is undoubtedly valuable; for few persons are better acquainted with the history of the progress and development of the Indies than the author.

LETTERS TO THE EDITOR.

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Velocity of Propagation of Electrostatic Force.

As we may have to wait some time for the experimental solution of Lord Kelvin's very instructive and suggestive problem concerning two pairs of spheres charged with electricity (see NATURE of February 6, p. 316), it may be interesting to see what the solution would be from the standpoint of existing electrical theories.

In applying Maxwell's theory to the problem, it will be convenient to suppose the dimensions of both pairs of spheres very small in comparison with the unit of length, and the distance between the two pairs very great in comparison with the same unit. These conditions, which greatly simplify the equations which represent the phenomena, will hardly be regarded as affecting the essential nature of the question proposed.

Let us first consider what would happen on the discharge of (A, B), if the system (c, d) were absent.

Let m_0 be the initial value of the *moment* of the charge of the system (A, B), (this term being used in a sense analogous to that in which we speak of the *moment* of a magnet), and m the value of the moment at any instant. If we set

$$m = \mathrm{F}(t), \quad \ldots\ldots\ldots \quad (1)$$

and suppose the discharge to commence when $t = 0$, and to be completed when $t = h$, we shall have

$$\mathrm{F}(t) = m_0 \qquad \text{when} \qquad t<0, \quad \ldots \quad (2)$$

and

$$\mathrm{F}(t) = 0 \qquad \text{when} \qquad t>h, \quad \ldots \quad (3)$$

Let us set the origin of coordinates at the centre of the system (A, B), and the axis of χ in the direction of the centre of the positively charged sphere. A unit vector in this direction we shall call i, and the vector from the origin to the point considered ρ. At any point outside of a sphere of unit radius about the origin, the electrical displacement ($\mathfrak{D}$) is given by the vector equation

$$\begin{aligned}4\pi\mathfrak{D} = &[3r^{-5}\mathrm{F}(t-cr) + 3cr^{-4}\mathrm{F}'(t-cr) + c^2r^{-3}\mathrm{F}''(t-cr)]\chi\rho \\ &-[r^{-3}\mathrm{F}(t-cr) + cr^{-2}\mathrm{F}'(t-cr) + c^2r^{-1}\mathrm{F}''(t-cr)]i, \quad . \ (4)\end{aligned}$$

where F denotes the function determined by equation (1), F′ and F″ its derivatives, and c the ratio of the electrostatic and electromagnetic units of electricity, or the reciprocal of the velocity of light. For this satisfies the general equation

$$-\nabla^2\mathfrak{D} = c^2 d^2\mathfrak{D}/dt^2, \quad \ldots\ldots\ldots \quad (5)$$

as well as the so-called "equation of continuity," and also satisfies the special conditions that when $t < 0$

$$4\pi\mathfrak{D} = m_0(3r^{-5}\chi\rho - r^{-3}i)$$

outside of the unit sphere, and that at any time at the surface of this sphere

$$4\pi\mathfrak{D} = m(3\chi\rho - i),$$

if we consider the terms containing the factor c as negligible, when not compensated by large values of r. That equation (4) satisfies the general conditions is easily verified, if we set

$$u = r^{-1}\,\mathrm{F}(t - cr), \quad \ldots\ldots\ldots \quad (6)$$

and observe that

$$-\nabla^2 u = c^2 d^2u/dt^2, \quad \ldots\ldots\ldots \quad (7)$$

and that the three components of $\mathfrak{D}$ are given by the equations

$$\left.\begin{aligned} 4\pi f &= -d^2u/dy^2 - d^2u/dz^2 \ \ldots \\ 4\pi g &= d^2u/dxdy \ \ldots\ldots\ldots \\ 4\pi h &= d^2u/dxdz \ \ldots\ldots\ldots \end{aligned}\right\} (8)$$

Equation (4) shows that the changes of the electrical displacement are represented by three systems of spherical waves, of forms determined by the rapidity of the discharge of the system (A, B), which expand with the velocity of light with amplitudes diminishing as r^{-3}, r^{-2}, and r^{-1}, respectively. Outside of these waves, the electrical displacement is unchanged, inside of them it is zero.

If we write (with Maxwell) $-d\mathfrak{A}/dt$ for the force of electrodynamic induction at any point, and suppose its rectangular components calculated from those of $-d^2\mathfrak{D}/dt^2$ by the formula used in calculating the potential of a mass from its density, we shall have by Poisson's theorem

$$\nabla^2(d\mathfrak{A}/dt) = 4\pi d^2\mathfrak{D}/dt^2,$$

or by (5),

$$\nabla^2(d\mathfrak{A}/dt) = -4\pi c^{-2}\nabla^2\mathfrak{D},$$

whence

$$d\mathfrak{A}/dt = -4\pi c^{-2}\mathfrak{D} \quad \ldots\ldots\ldots \quad (9)$$

From this, with (4), and the general equation

$$d\mathfrak{A}/dt + 4\pi c^{-2}\mathfrak{D} + \nabla\mathrm{V} = 0,$$

we see that during the discharge of the system (A, B) the electrostatic force $-\nabla\mathrm{V}$ vanishes throughout all space, while its place is taken by a precisely equal electrodynamic force $-d\mathfrak{A}/dt$.

This electrodynamic force remains unchanged at every point until the passage of the waves, after which the electrostatic force, the electrodynamic force, and the displacement, have the permanent value zero.

If we write *Curl* for the differentiating vector operator which Maxwell calls by that name, equations (8) may be put in the form

$$4\pi\mathfrak{D} = \mathrm{Curl\ Curl}\ (iu),$$

whence

$$d\mathfrak{D}/dt = (4\pi)^{-1}\,\mathrm{Curl\ Curl}\ (idu/dt).$$

From $d\mathfrak{D}/dt$ we may calculate the magnetic induction $\mathfrak{B}$ by an operation which is the inverse of $(4\pi)^{-1}$ Curl. We have therefore

$$\mathfrak{B} = \mathrm{Curl}\ (idu/dt),$$

or

$$\mathfrak{B} = [r^{-3}\mathrm{F}'(t - cr) + cr^{-2}\mathrm{F}''(t - cr)](yk - zj).$$

The magnetic induction is therefore zero except in the waves.

Equations (4) and (9) give the value of $d\mathfrak{A}/dt$ as function of (t and r). By integration, we may find the value of $\mathfrak{A}$, Maxwell's "vector potential." This will be of the form of the second member of (4) multipled by $-c^{-2}$, if we should give each F one accent less, and for an unaccented F should write $\mathrm{F}_{,}$, to denote the primitive of F which vanishes for the argument ∞.

That which seems most worthy of notice is that although simultaneously with the discharge of the system (A, B) the values of what we call the electric potential, the electrodynamic force of induction, and the "vector potential," are changed throughout all space, this does not appear connected with any physical change outside of the waves, which advance with the velocity of light.

If we now suppose that there is a second pair of charged spheres (c, d), as in the original problem, the discharge of this pair will evidently occur when the relaxation of electrical displacement reaches it. The time between the discharges is, therefore, by Maxwell's theory, the time required for light to pass from one pair to the other.

It may also be interesting to observe that in the axis of χ, on both sides of the origin, $\chi\rho = r^2 i$, and equation (4) reduces to

$$4\pi\mathfrak{D} = [2r^{-3}\mathrm{F}(t - cr) + 2cr^{-2}\mathrm{F}'(t - cr)]i.$$

Here, therefore, the oscillations are normal to the wave-surfaces. This might seem to imply that plane waves of normal oscillations may be propagated, since we are accustomed to regard a part of an infinite sphere as equivalent to a part of an infinite plane. Of course, such a result would be contrary to Maxwell's theory. The paradox is explained if we consider that the parts of the wave-motion, expressed by F and F′, diminish more rapidly than those expressed by F″, so that it is unsafe to take the displacements in the axis of χ as approximately representing those at a moderate distance from it. In fact, if we consider the displacements not merely in the axis of χ, but within a cylinder about that axis, and follow the waves to an infinite distance from the origin, we find no approximation to what is usually meant by plane waves with normal oscillations.

J. WILLARD GIBBS.

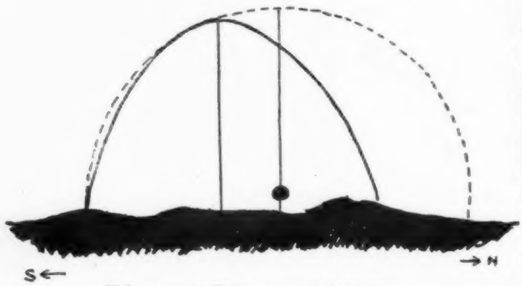
New Haven, Conn., March 12.

An Unusual Solar-Halo.

ON March 17, at Göttingen, a curious solar halo was observed by a friend and myself towards the time of sunset. The weather that day had been beautifully fine, but towards 5h. p.m. (Mean European Time) thin light clouds began to form, which covered the heavens with a thin white raiment. When the sun was

about a few degrees from the horizon (the horizon at the place of observation was not the true one, for a large but not very distant hill intervenes towards the west), there seemed to be suddenly formed a halo of peculiar shape. Its form may be described as nearly, if not quite, parabolic, the axis of the parabola being vertical. Curiously enough, this parabolic form was not symmetrical with regard to the position of the sun, but the latter was situated some distance to the north of the axis. The above phenomenon was observed at about 5h. 50m.-5h. 55m. p.m.

A few minutes afterwards (6h. 5m.), this parobolic form slowly underwent a change, and after a minute or two a circular



Halo at sunset, February 17, 1896, Göttingen.

halo concentric about the sun was distinctly visible. While the concentric halo was in the act of being formed, that portion of the parabolic halo towards the south seemed to maintain its position, but the northern end moved distinctly more north until the position of the sun was half-way between the two. The parabolic form *may* have been caused by the positions of the light fleecy clouds, apparently distorting the halo on the northern side and making the whole appear parabolic; but the change of shape was so considerable, that this explanation seems hardly satisfactory. WILLIAM J. S. LOCKYER.

Remarkable Sounds.

MR. GODWIN-AUSTEN'S letter in NATURE of January 16, reminds me of similar sounds heard at Java in the year 1881. I was then building a railway tunnel through the Gunung Kendang, a range of hills about 100 metres high, situated between the towns of Sukabumi and Tjiandjor, Preanger Regencies, a district where more seismic disturbances take place than in almost any other district of Java.

One morning at about six o'clock, when at breakfast, I was startled by a very loud detonation which made me fear that one of our small vertical boilers at the other side of the works had exploded. I at once sent a man over the hill to ask for information, and received a note from my European assistant stating that no accident had taken place, but that he also heard the detonation and took it for an accidental explosion of some cases of dynamite at Tjiperda, a kampong about six miles from the tunnel, the headquarters of one of the European railway contractors. He at once went thither to see whether any assistance might be wanted, but found that nothing unusual had happened. The contractor, however, told him that at the very moment that we had heard the detonation he had felt a very severe vertical shock of earthquake, but had heard no sound.

In this same tunnel I experienced twice a very severe horizontal shock of earthquake which made a creaking sound in the timbering from end to end in the adits, causing some of the horizontal timbers which had not yet been spiked to fall down. The first time that this happened the coolies bolted, but the second time I managed to keep them in the works to watch the timbering. TH. DELPRAT.

Malang, Java, February 18.

An Excellent View of the Retinal Circulation.

ON a cycling tour recently, after riding some forty miles, with much hill-climbing and against a strong wind, I lay down on a grassy bank facing the east, towards sunset. Viewing the clear eastern sky, I obtained a most remarkable view of my own retinal circulation. A companion also got an excellent view of his own blood corpuscles. The apparent circulation occupied a considerable portion of the visual field, and a most vivid conception was obtained of the relative slowness of movement in the capillaries. It occurred to me afterwards that the reason of the phenomenon was the hyperæsthesia of the retina, caused by the dilatation of the arterioles, which is a characteristic of excessive cycling. It would be interesting to learn whether others have obtained similar experiences. JAMES W. BARRETT.

Melbourne, Australia.

Butterflies and Hybernation.

SOME time late in last autumn, a tortoiseshell butterfly took refuge in a small bath-room in this house, established itself on the ceiling, and there remained, immovable, throughout the winter. On the 10th of this month it shifted its position, and on the 12th flew out of the open window. On the 19th, and again to-day, I have seen a tortoiseshell butterfly fluttering about the garden, and should not be surprised if this early rover were the same individual as that which has undoubtedly wintered here. Half a dozen gauzy-winged green flies also hybernated in close company with the butterfly, but they woke up and flew a fortnight or so before the tortoiseshell butterfly stirred. DAN. PIDGEON.

The Long House, Letherhead, March 24.

Children's Drawings.

As supplementary to the interesting note in NATURE of February 20, on children's drawings, I may mention that some children of my acquaintance show what seems a strong native tendency to reverse right and left in drawing such letters as L and J, making them ⅃ and ⅂. It is possible this confusion is akin to that confusion of right and left which one first feels on using a mirror for toilet purposes, as shaving, &c.

Lake Forest, Illinois, March 16. HIRAM M. STANLEY.

"Testacella haliotidea."

ON addressing you some time ago on the subject of Worcestershire being a habitat of what I regard as this mollusc, some of your contributors applied for specimens. I have now six to give away. One of your contributors doubted whether the specimen I then had was Haliotidea, on account of alleged rarity. The same doubt applies now.

Worcester Museum, March 23. J. LLOYD BOZWARD.

An Early Swarm of Bees.

A SWARM of bees on March 23 is, I think, so unusual, that you may perhaps like to be informed that one was taken here yesterday. A. PAGE.

Tendring, Essex, March 24.

THE MANAGEMENT AND PROTECTION OF FORESTS.[1]

I.

PROF. SCHLICH'S important work is approaching completion. The two first volumes were noticed in December 1889 and July 1891.[2] Of these, it is understood, a new edition will soon be necessary. The third volume, which deals with forest management, is about to appear in a Spanish translation. Vol. iv. is an English adaptation of an excellent German book on forest protection, by Dr. Richard Hess, Professor of Forestry at the University of Giessen. It is the work of Mr. Fisher, formerly Conservator of Forests and Director of the Imperial Forest School at Dèhra Dùn in North-Western India. The last volume will deal with forest utilisation. In the present article, we propose to deal with the subjects of the third and fourth volumes, viz. the management and the protection of forests.

[1] "A Manual of Forestry," by William Schlich, C.I.E., Ph.D. Vol. iii. (pp. xix + 397). "Forest Management," by William Schlich. Vol. iv. (pp. xix + 593). "Forest Protection," by W. R. Fisher, B.A. (London: Bradbury, Agnew, and Co., 1895.)

[2] NATURE, vol. xli. p. 121; vol. xliv. p. 265.

The management of forests depends upon the objects which the proprietor desires to realise. These objects may be of two kinds: they are either indirect, such as landscape beauty, protection against erosion, landslips, avalanches; or they are direct, the production of timber or other forest produce, so as to yield the largest possible permanent income to the proprietor. Dr. Schlich deals with the attainment of the direct objects, that is, with the economic working of forests; but he justly observes, that a forest under good economic management, as a rule, is capable of yielding all those indirect advantages that may reasonably be expected from it.

As explained on a previous occasion, Dr. Schlich's manual is, in the first instance, intended for the instruction of students preparing for the Indian Forest Service at Coopers Hill College. At the same time, there seems good ground for hoping that eventually it may also be useful to proprietors, land-agents, and wood-managers in Great Britain, as well as in the Colonies and the United States of North America. The third volume of the manual has a special value for persons interested in the management of woodlands in Great Britain; it is the first really comprehensive work upon this subject that has been published in English, and those who may take the trouble to work through its pages, will find that it will enable them to strike out a new line in the management of their woodlands. In 1883, another Indian forest officer, who had received his professional education in Germany, Mr. J. L. Laird MacGregor, now Conservator of Forests in the Bombay Presidency, attempted to place portions of the subject before English readers, under the title "Organisation and Valuation of Forests." (London: Wyman and Sons.)

At the outset, it will be necessary clearly to understand what the author intends by the term "forest management." Forestry, like medicine, engineering, or agriculture, originally commenced as an empirical routine; but its operations are now built upon the results obtained by researches in numerous branches of pure science. The most important of these are mathematics, botany, zoology, chemistry, geology, law, and political economy. Apart from these auxiliary sciences, forestry proper deals with the following subjects: (1) the raising and maintenance of woods, or sylviculture; (2) the protection of forests against damage; (3) the utilisation of forest produce; (4) forest management; (5) forest law.

The last-named subject has been dealt with in a separate work,[1] which, though not published as part of Dr. Schlich's manual, essentially belongs to this series of forest publications. The author, Mr. B. H. Baden-Powell, in 1868 was Small Cause Court Judge at Lahore, and consented to be employed during a series of years in the Indian Forest Service, then a small and humble concern, the progress of which was not generally regarded with favour. The main object of this measure was to secure his assistance in the matter of forest legislation. After doing excellent work as Conservator of Forests in the Punjab, and as Inspector General of Forests to the Government of India, Mr. Baden-Powell resumed his judicial work, and closed his Indian career as Judge in the Chief Court of the Punjab.

The first volume of Dr. Schlich's manual is introductory, the second deals with sylviculture, the third with forest management, the fourth with forest protection, while the fifth will teach utilisation of forest produce. Forest management is built upon the other branches, and under a strictly logical arrangement it ought to be the last volume of the series. This, however, would have delayed its publication. It may be objected that the term "forest management" has a wider meaning in English than that attributed to it by Dr. Schlich, that it comprises all operations of forestry, including sylviculture protection and utilisation of forest produce. In his manual the author uses it in a somewhat restricted sense, but this restriction is justified; it is convenient, and cannot lead to misconception. In French this branch of forestry is called *aménagement des forêts*, in German the usual term is *Forsteinrichtung*. MacGregor, in the work quoted, designates a portion of it as *Forest Organisation*. The term selected by Dr. Schlich seems the most suitable.

Forest management, as here understood, comprises three main subjects: mensuration, valuation, and working plans. Forest mensuration deals with the instruments used, the measurement of timber, standing and felled, it determines the volume of entire woods, the age of trees and woods, as well as the increment of woods. It appears necessary here to draw attention to another technical term, which, though English, is used in a definite sense. Dr. Schlich employs the term "wood" to designate what in German is called *Bestand*, meaning part of a forest forming a unit of fairly the same description. It might be objected that a "wood" is generally understood to mean an isolated small forest block, surrounded by clearings or by prominent natural boundaries. It will be a great convenience if Dr. Schlich's use of the term "wood" is accepted. The volume of a wood standing, say, on one acre of ground, is the product of two factors, the number of trees per acre and the mean volume of those trees. Again, the volume of a tree is the cylinder, height × sectional area, multiplied by a coefficient, called the form factor, which is different for each species, and in each species varies according to age and size of the tree. By a most elaborate system of measurements of many hundred thousand trees of all ages grown in different localities, form factors have now been established in Germany for most of the principal species. These form factors are governed by laws peculiar to each species. Thus, for trees 50 and 100 feet high of Scotch pine and Beech, the following factors are used to calculate the volume of timber down to three inches diameter:

	50 ft.	100 ft.
Scotch Pine	0·48 ...	... 0·45
Beech	0·40 ...	... 0·51

It must be distinctly understood that these form factors are only applicable to forests managed upon proper economic principles, where the trees, while young, are allowed to grow up crowded in compact masses, so as to form straight well-shaped stems, free from knots and branches, and are afterwards thinned out methodically, with the object of leaving in the final crop only well-shaped sound trees, likely to yield the most valuable timber. To trees grown in open park-like woods, these form factors would not be applicable.

Hand in hand with the determination of form factors, yield tables have been prepared in Germany for the principal species. These yield tables give the volume of timber in completely stocked woods of the different species standing on a given area at different ages, and in localities of the different quality classes. The work of examining the data, upon which these yield tables have been based, has led to an important result, viz. that the mean height of a wood as a rule indicates the quality of the locality. On good soil and under conditions otherwise favourable, the mean height of a wood is much greater than one of the same age which has grown up under less favourable conditions. Indeed, it is possible, with the help of yield tables to ascertain the volume of an even aged wood, the age of which is known, by determining the mean height of the trees composing it. The following extract from the yield table for Scotch pine in Germany, mainly taken from the figures given by Dr. Schlich, may serve to explain this.

[1] "Forest Law," by B. H. Baden-Powell, C.I.E., late of the Bengal Civil Service. (London: Bradbury, Agnew, and Co., 1893.)

Volume and Volume-increment of Timber down to 3 inches diam. Net value and Value-increment. All on one Acre, stocked with Scotch Pine of middling quality.

Age, years	60	70	80	90	100
Number of trees per acre ...	516	393	316	266	230
Mean height, feet	51	57	63	67	71
Volume, cubic feet, solid ...	3713	4183	4587	4902	5158
Current annual increment, cubic feet, solid	47·0	40·4	31·5	25·6	
Volume increment, per cent.	1·2	0·93	0·60	0·51	
Net value of stock (shillings)	1186	1683	2225	2789	3376
Volume- and value-increment, per cent.	3·76	2·83	2·29	1·93	

If two woods, known to be 60 and 100 years old, have a mean height of 51 and 71 feet respectively, it follows that they belong to the class, of which an extract is here given, which is known as the third or middling class, and, if completely stocked, the volume standing on one acre would be 3713 cubic feet in the one, and 5158 cubic feet in the other case. Other Scotch pine woods of the same age, if their mean height were greater, would belong to a higher quality class, and if fully stocked, their volume would be that recorded in the yield tables under their class. It stands to reason that in woods not fully stocked the timber per acre is less in inverse proportion to the degree of completeness.

The great practical importance of height-growth will perhaps be better understood by reference to matters which, many years ago, have exercised considerable influence upon the development of regular forest management in India. The writer of these lines, on taking charge, in January 1856, of the Pegu teak forests, made it his first duty to ascertain which were the most valuable forest tracts in that country. The number of teak trees of the different age classes on the square mile, he ascertained by a system of linear valuation surveys, laid through the forests in all directions. At the same time he measured the height of trees in all districts. The data thus obtained, the timber standing on the ground, and the height of the trees, particularly of the younger classes, enabled him to classify the forests, and to pick out those which were the most valuable. The measures which he had introduced, had gained him the confidence and goodwill of the Karen and other inhabitants of the forests, for those measures gave to the people profitable employment in timber operations, and this made them allies, instead of enemies, in regard to forest protection. The merchants of Rangoon, on the other hand, naturally desired to get the forests into their own hands, and, backed by the influence of the powerful mercantile firms of Calcutta, they induced the Government of India to order the Pegu forests to be thrown open to private enterprise. These orders had to be carried out; but, fortunately, they did not require that the whole of the forests should be thrown open at once. Those districts, therefore, in which the growing stock of teak timber, in regard to height and otherwise, was most promising, were for a time retained under control of the Forest Department, while the rest were thrown open to private enterprise, in accordance with the orders received. This was in 1861. Subsequently a different view of the question was taken by Government; the arrangements which had been made could not, however, be cancelled. The mischief had been done; but, fortunately, it had been limited to the less valuable districts. The really valuable forests, which had been reserved in 1861, had been saved, and this made it possible to maintain a profitable system of regular management.

The little table, entered on page 511, illustrates the growth of a Scotch pine wood of middling quality between the ages of sixty and a hundred years. As the wood advances in age, the number of trees diminishes, but the remaining trees are taller and heavier, and hence the total volume increases. During these 40 years no less than 286 trees have died or been thinned out, and the skill of the forester consists in this, that the final crop is composed of sound and well-shaped trees, so that their timber may fetch the highest price obtainable. These figures show further, that, while in the first period of 10 years, between 60 and 70, the timber produced per acre amounted to 470 cubic feet, or 47 cubic feet a year, only 256 cubic feet, or 25·6 cubic feet annually, were produced from the 90th to the 100th year.

The current annual increment is greatest while the forest is young, in the case of Scotch pine between the ages of 30 and 40, after which it diminishes steadily. The annual increment may be regarded as a percentage of the growing forest capital. Between the years 60 and 70 the increment per cent. (p) would be determined by the formula: $4183 = 3713 \times 1{\cdot}0p^{10}$, which makes $p = 1{\cdot}2$. Between the years 90 and 100 the increment per cent. is only 0·51. The maintenance of a forest, which increases at a rate so slow and so steadily diminishing, at first sight appears to be a most unprofitable undertaking. Fortunately the market value of the timber up to a certain point increases with the age of the wood. The net value of the growing stock (less the cost of cutting, carriage, and other expenses) of the wood exhibited in the table at the age of 60 years is 1186 shillings, rising to 1683 shillings at the age of 70. During this period the value- and volume-increment per cent. is 3·76, but it falls steadily to 1·93 per cent. between the years 90 and 100. Obviously, from a purely financial point of view, it is best to cut the wood when it is between 80 and 90 years old, and to invest the proceeds in Consols at 2½ per cent., for its maintenance beyond that age entails a loss of interest. The increment, that is the interest on the growing capital of the forest, is less than can otherwise be obtained on perfect security.

It is also evident that the value- and volume-increment per cent. may be used to aid in determining the most profitable rotation to adopt in the management of a forest. In the vicinity of coal- or other large mines, where pit-props find a ready sale, a rotation between 60 and 70 years, and even lower, would be most profitable. Where, however, the chief demand is for building timber, or there is a risk lest an over-production of smaller wood might lower prices, the rotation should be higher, 70 to 80 or 80 to 100 years. The value- and volume-increment per cent. does not, however, correctly express the rate at which the forest capital works. For this purpose the formula must be completed by inserting the annual expenses for taxes, administration, &c., as well as the rent of the soil. The result is called the *forest per cent.* To discuss this part of the subject would, however, lead too far on the present occasion.

Part ii. deals with forest valuation. Obviously it is often necessary, when a forest is to be divided, or assessed or sold, to determine its capital value. The English reader may be disposed to think this an extremely simple matter. The value of a piece of property is either its selling value or its productive value, and these can readily be ascertained by the prices paid for forest land in the open market, or by the rent derived from forest land. Sales of forest land, however, do not often occur, and when a sale takes place, the price realised for one piece of forest does not give the value of another piece. Soil, aspect, elevation, and the other factors which influence the annual timber production and the rate at which the timber can be sold, must be considered, and more than these, the actual condition of the growing stock depending upon species, age, and previous treatment.

Nor does the rental of forests come to our aid; forest lands, as a matter of fact, are not often leased out, the difficulty being to make sure that the capital value of a forest has been maintained unimpaired during the lease. The rent obtainable from a field, or from a piece of grass-

land, whether let as a sheep-walk or for shooting, is known or can readily be ascertained. The same holds good in the case of osier-beds, which are cut over annually or every second year, and, in the case of coppice woods, which are worked on a short rotation. In all these cases the yield is approximately the same every year, and so is the annual outlay for labour and manure. Matters are complicated where standards are held over in the coppice, and more complicated in the case of high forest. A piece of high forest consists of trees which require eighty or hundred years, or even longer, to come to maturity. It consists of woods of all ages, and in the same wood trees of different species and of different ages are often found mixed. Under good management, a piece of high forest, if of sufficient extent, ought to yield, year after year, approximately the same quantity of timber, and hence a forest under a good system of management, in accordance with a well-considered working plan, is analogous to a field or meadow. When this, however, is not the case, it obviously is not a simple operation to determine the annual yield and the capital value of a forest. The annual yield is derived, in the shape of thinnings and final cuttings, from certain compartments this year, and from other compartments another year. Data extending over a long series of years would be needed to ascertain its average amount.

It may be objected that the capital value of a forest consists of two items, the value of the land and the value of the growing stock; that the former can generally be estimated within narrow limits, and that the latter should be calculated by adding up the market value of the timber standing in each compartment. This method, however, would leave out of account all young woods, which do not yet contain marketable timber; it would, in fact, treat them as blanks. The result of such a proceeding would be misleading, for obviously the capital value of a forest depends upon the yield which may in future be expected from it. And the future yield depends quite as much upon the condition of the young woods, which eventually are to furnish thinnings and the final crop, as upon the timber which at the present time happens to be marketable.

On the assumption that a forest is worked in accordance with a system settled beforehand, its capital value and its rental can obviously be calculated with the aid of yield tables. All net income, that is, the amounts expected to be realised by the sale of timber, less the cost of cutting, carriage, and other expenses, is discounted to the present time, and from the present value of all income is deducted the present net value of all expenses expected to be incurred upon the property. The result thus obtained is called the expectation value. Starting from an area not stocked, the *soil expectation value* is obtained. Thus, on the assumption that Scotch pine is to be planted, the soil expectation value of an acre of land of middling quality, such as that to which the data given on page 512 relate, will be as follows:—

Under a rotation of		With a net rental of
60 years	196*s*. ...	... 4·90*s*.
70 ,, ...	236*s*. ...	... 5·91*s*.
80 ,, ...	250*s*. ...	... 6·25*s*.
90 ,, ...	245*s*. ...	... 6·14*s*.
100 ,, ...	229*s*. ...	... 5·73*s*.

In calculating these values, the question had to be settled which rate of interest should be employed. As regards security, forest property has the drawback of possible damage by fire, storms, snowbreak, and insects. On the other hand, once placed under systematic management, a forest yields approximately equal returns annually, while those of fields and grass-lands vary according to the seasons. Once established, a forest requires less labour, and can be left alone for a time without much risk, for the timber continues to grow all the same. Lastly, the yield of several years may be anticipated, if money is wanted, or if it is desired to take advantage of a temporary rise in timber prices. These are substantial advantages of forest property, which make it a desirable investment, and therefore justify a low rate of interest. In these calculations, as well as in all others in this portion of his manual, the author has employed the interest of British Consols, that is, 2½ per cent. The calculation of the soil expectation value will be understood at a glance by stating the formula for a rotation of 80 years:

$$S_e = \frac{Y_{80} + T_{30} \cdot 1{\cdot}025^{50} + \ldots + T_{70} \cdot 1{\cdot}025^{10} - c\ 1{\cdot}025^{80}}{1{\cdot}025^{80} - 1} - \frac{e}{0{\cdot}025}$$

Y_{80}, the final yield at the end of the rotation is, according to the table given, worth 2225 shillings; the thinnings at the ages of 30, 40, 50, 60 and 70 years are worth $T_{30}=4$, $T_{40}=36$, $T_{50}=67$, $T_{60}=86$, $T_{70}=91$ shillings. These values are all prolonged to the end of the rotation, and the same is done with c, the cost of formation, here assumed to amount to 60 shillings, which is deducted from the sum of final and intermediate yields. The difference is the rent yielded by the forest every 80 years, that is, at the end of each rotation, and the present value $\frac{r}{1{\cdot}0p^{80} - 1}$ of this perpetual rent, after deducting the capital value of e, the annual expenses for administration, taxes, &c., ($e = 3s.$), represents the soil expectation value.

All other data remaining the same, the value of S_e varies with the length of the rotation adopted, and in the present case its value culminates for a rotation of 80 years. Obviously this is financially the most profitable rotation which yields the highest net rental, 6·25 shillings per acre. Under this rotation the capital value of the growing stock is utilised to its full extent; if the wood is allowed to grow older, both soil expectation value and net rental diminish. It will be understood that on the data here assumed, it will pay to plant Scotch pine on land of middling quality, if that land can be purchased at 250 shillings (£12 10*s*.), or less, an acre.

The method here explained can be employed to determine the expectation value, not only of land, on the assumption that it is to be planted up with Scotch pine or other trees, but also of existing forests. The expectation value of a normal forest, for instance, consisting of 80 compartments of one acre each, all of the same middling quality, completely stocked with Scotch pine, in a regular succession of ages, the wood on the youngest compartment being 1, that on the oldest 80 years old, would stand as follows:—

	£		£	*s*.	*d*.
Growing stock ...	3418	or, per acre ...	42	14	6
Soil	1000	,, ...	12	10	0
	4418	,, ...	55	4	6

It must be distinctly understood that these calculations are based upon assumptions, which may not in all cases be realised. The first assumption is that the plan adopted, upon which the formula is based, will be strictly carried out, that thinnings and other operations will not be interfered with by fires, storms, snowbreak, insects, or other damage, and that the areas will always be fully stocked with even aged timber. The second is, that the data of the yield tables will actually hold good in the case in point. The third assumption is, that the prices realised by sale of the timber, that wages and other circumstances which govern the value of c and e, will be, and remain, as entered in the calculations.

There is some analogy with engineering formulæ. These the practical engineer uses as his guide, not blindly, but with circumspection and with due consideration of all circumstances which may affect the result. The difference is this, that the forester attempts to express by a mathematical formula the growth of trees,

of organised beings, the development of which is governed by a multitude of influences, varying incessantly. Nevertheless, if used with due caution, these mathematical formulæ, elaborated with praiseworthy perseverance by foresters in Germany, will be found most useful aids in considering the difficult problems which forestry presents in all countries. Some of these problems can, others cannot, in the present state of our knowledge, be solved by the use of mathematical formulæ. Space forbids a further discussion of this subject.

In the kingdom of Saxony the State owns a forest area of 430,000 acres, which, after deducting all expenses, yields a mean annual net revenue of £390,000, or 18*s.* per acre. For many years it has been an established practice to determine, at intervals of ten years, the capital value of each forest range, soil and growing stock, and to calculate the rate of interest which, under existing management, that capital yields. The total area consists of 107 forest ranges or executive charges, and authentic statements, giving the financial result of forest management in each range, are published annually. During the five years ending with 1892 the average capital value of the entire area (soil and growing stock) amounted to 15 millions, or about £36 an acre. During this period, therefore, these forests have yielded interest on the capital involved at the rate of 2·6 per cent. Many of the 107 forest ranges have yielded less than 2 per cent., but a large number regularly yield more than 3 per cent. Compared with the State forests in other countries of Germany, those of Saxony have great advantages. The country is densely inhabited, up to the edge of the forests, factories and other industrial establishments are numerous, and there is a complete system of roads and railways. The consequence is, that timber, even of moderate dimensions, commands high prices, and that the produce of thinnings finds a ready market. Under these favourable circumstances, most of these forests are worked on a short rotation, which, it will be evident from the preceding remarks, is always more likely to lead to good financial results, than if the woods were permitted to attain a great age. A large portion of this area has gradually been converted into pure spruce forests, managed on a rotation of eighty years. On other grounds, it may, perhaps, not have been wise to rely upon pure spruce forests. Up to the present time, however, there has been no serious damage from insects or fungi.

In most other countries of Germany the public forests—that is, those which belong to the State, to towns, village communities, and other public corporations, and most of the larger private forests—are managed on rotations considerably longer, and the consequence is, that the capital involved (soil and growing stock) does not yield as high interest as in the State forests of Saxony. The Spessart, for instance, an extensive forest area belonging to the State in the kingdom of Bavaria, contains a large growing stock of old oak timber, 250 to 450 years old, which, if cut and sold at the present time, would fetch about £1,500,000. The existing working plan governs operations during a period of 120 years, from 1888 to 2007, and particularly prescribes the manner in which the old standing oak timber shall be utilised. About 60 per cent. of the quantity alluded to consists of trees 300 to 450 years old, with hardly any volume- or value-increment. These it is proposed to cut during the next forty years. If they were cut now, and the proceeds were used to redeem part of the State debt, upwards of £27,000 a year would be saved in interest. The remaining 40 per cent. consists of trees now about 250 years old. These will furnish the yield in oak timber from 1936 to 1983, and when they are cut the volume will be greater, and the timber, being larger, will fetch much higher prices. Nevertheless, in the case of this portion, also, there will be considerable loss of interest. This sacrifice of interest is made deliberately by the Government of Bavaria, with the full consent of the Parliament at Munich, because it is considered desirable to maintain a regular supply of oak timber from this source, upon which numerous industrial establishments in the large villages all round the Spessart to a great extent depend.

And there are many other forest tracts in Germany of large extent, both public and private, which still contain enormous stores of old-growing timber, the inheritance of several centuries. In such cases it is right on many grounds to spread the removal of the old timber over a long series of years, and rather to work the forests on conservative than on purely financial principles. In Great Britain, however, circumstances are more similar to those which exist in Saxony, and hence, in the management of its woodlands, financial considerations will probably preponderate.

Part iii. deals with working plans; and this portion of the book cannot be sufficiently recommended to forest proprietors in Great Britain. In the first volume of his manual, Dr. Schlich justly drew attention to the large importation into the United Kingdom of timber and other forest produce, and he estimated that £12,000,000 a year represented the value of oak, birch, coniferous and other woods imported from abroad, that might be produced in Great Britain. This was in 1889; it was a cautious estimate, and since it was made, the imports into the United Kingdom have increased steadily.

Landed proprietors in Great Britain have fortunately not yet suffered to the same extent by the decline in the price of wheat and other agricultural produce, as proprietors in some parts of Germany. Yet their income has diminished, and in many cases it doubtless would be desirable to increase that income. Much might be done in this direction, if the management of existing woodlands were improved, and if land which it does not pay to keep under the plough, or to convert into grass land, were planted up and converted into forest. One objection commonly raised to this proposal is, that timber traders prefer imported to home-grown timber. That this is the case there is no doubt, and in the preface to the present volume Dr. Schlich explains the reason. Home-grown timber cannot, as a rule, compete with imported timber, because it has not grown up in dense compact masses. The woods are open, hence the bole is short, branched, and knotty. There are exceptions, but open park-like woods are the rule, and these cannot be expected to yield timber of good quality. A different system of sylviculture must be adopted. Of greater importance still is the adoption of regular systems of management. Timber of different kinds and of the exact qualities required by the market is imported regularly in sufficient quantities at the principal ports of the United Kingdom; the timber trader is able to make the needful arrangements to supply his customers, because he is certain that whatever he may require to meet their demands, will be available at the right time. Home-grown timber, on the other hand, is thrown upon the market in an irregular fashion. All at once heavy cuttings are made at one place, to provide money, or for other reasons, and then perhaps nothing is cut in the same district for years to come. The necessary consequence of such a system, or rather want of system, is that the timber is not sold at its full value. And when a calamity occurs, such as the storm of 1894, the timber blown down cannot be sold, except at ruinously low rates. The only remedy is the adoption of methodically arranged working plans in all forest tracts throughout the country. Among other things, such working plans determine the annual yield of each forest district. It does not follow that the yield once fixed must be pedantically maintained. A good working plan is elastic, and permits deviations to suit the interests of the proprietor. But if a methodical system of working is the rule in all forest districts, these deviations will generally compensate each

other, and the market will nevertheless be regularly supplied.

What, then, is a working plan? The German term is Wirthschafts plan, and the English term (working plan) was first used in 1856, when the writer of these lines commenced to work the Pegu teak forests on a regular system. The number of teak trees of the different age classes was approximately determined by an elaborate system of valuation surveys. It was found that the trees of the second class were sufficiently numerous to take the place of the first class trees, and that the same was the case with the younger classes. It was also ascertained, that twenty-four years on an average would be required for the trees of the second class to attain first class size. The result was that the removal of the first class trees, those which were fit to yield marketable timber, must be spread over at least twenty-four years; and upon this very simple principle, a working plan, intended to provide, in the first instance, for six years only, was established for the different forest districts. After the expiration of the first six years, this plan was renewed, and subsequently modified and elaborated in detail. The principle, however, has been maintained to the present day. These are the bare outlines of the scheme, which has not only ensured a sustained yield, but, and that is very important, has been readily intelligible to all.

(*To be continued.*)

THE NEW PROCESS FOR THE LIQUEFACTION OF AIR AND OTHER GASES.

THE liquefaction of air, and the rest of the so-called permanent gases, is an achievement which belongs to quite recent times. Faraday cooled and compressed gases by such means as were at his disposal, with results which are well known; but it was the experiments of Andrews, published in 1869, which taught physicists the fact that until the cooling has been effectual no amount of pressure will liquefy the gas; in fact, that every gas has a critical point below which its temperature must be reduced before pressure can bring about liquefaction. The critical points of oxygen and the components of air are very low. Hence it was not till 1877 that these gases were liquefied by Pictet and by Cailletet. The former reached the necessary temperature by two stages, using first liquid sulphur dioxide, then liquid carbon dioxide, both boiling under reduced pressure. Cailletet used the principle of cooling by sudden release from higher to lower pressure. The introduction of liquid ethylene as a cooling agent enabled experimenters to make another step forward; for, with the help of liquid ethylene, Wroblewski and Olszewski first obtained liquid oxygen in quantity far larger than would be possible in any form of Cailletet's apparatus, and without the complicated machinery of Pictet. Liquid oxygen itself thus became available as a refrigerating agent, and afforded the means of cooling a tube containing any other gas to a temperature lower than ever; namely, about 211° below zero Centigrade. With this cooling agent, and with the further cooling produced by expansion of the confined gas from a pressure of 150 atmospheres to 20 atmospheres, hydrogen has been liquefied by Olszewski. Suggestions have from time to time been made as to the possibility of applying the reduction of temperature, consequent upon the expansion of a gas when released from a high pressure, to the further cooling of the compressed gas; but no practical steps had been taken in this direction till the publication, in October last, of Herr Linde's successful liquefaction of air by the application of this principle. It now appears, however, that Linde has not only been anticipated in the application of the principle, but that a more effective apparatus than his has been devised. On Saturday, March 21, a demonstration was given, at Brin's Oxygen Works, of the construction and use of a new apparatus, the subject of an English patent, dated May 23, 1895, standing in the name of Dr. William Hampson. The apparatus consists of three coils of narrow copper tubing, arranged concentrically in a metal case, and connected successively together, as shown in the accompanying diagram (Fig. 1), which displays a vertical section of the apparatus. The gas, say oxygen, enters the outer coil under a pressure of 120 atmospheres, passing from this into the second, and from this into the central coil, which is surrounded by a

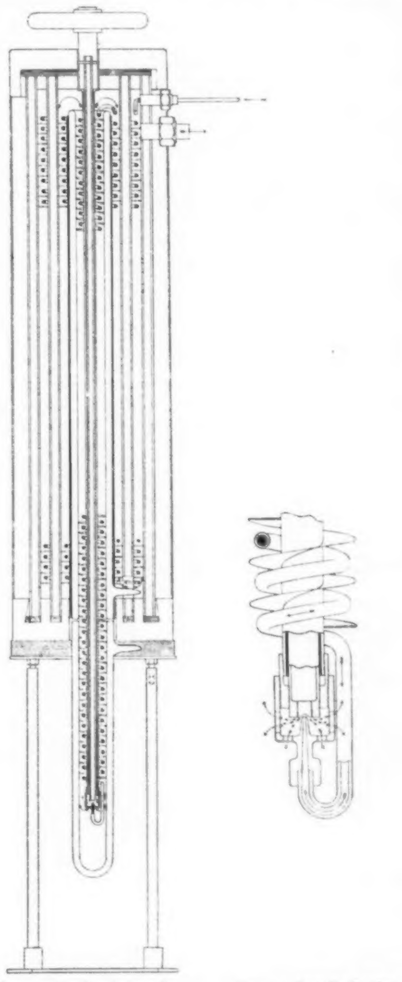


FIG. 1.—Sectional elevation. FIG. 2.—Detail of valve.

cylindrical glass vacuum-jacketed vessel as devised by Prof. Dewar. The two outer coils are separated from each other by vertical divisions of the case, and the spiral of the central coil is followed by a flat spiral of sheet copper. When the gas reaches the extremity of the central coil, it escapes through a fine orifice of peculiar construction, formed by bringing two knife-edges closely together (shown in Fig. 2). The size of the orifice can be regulated by means of an ebonite rod, which passes up the axis of the apparatus, and terminates in a handle at the top. After its escape the whole of the gas cooled by

expansion passes through the spaces surrounding the pipe through which the compressed gas is passing to the point of expansion, and so makes this gas, still under pressure, cooler than it was itself while under compression. The compressed gas consequently becomes at the point of expansion cooler than that which preceded it, and in its turn follows backwards the course of the still compressed gas, and so makes the latter cooler than before expansion, and therefore also cooler than ever after expansion. This intensification of cooling (always assuming sufficient protection against access of heat from the outside) is only limited by the liquefaction of the gas, the temperature of liquefaction being in the case of oxygen $-180°$ C. The apparatus exhibited measures 28 inches deep by 7 inches in diameter, and when once cooled down, that is, in about half an hour, it yields liquid oxygen at the rate of about seven cubic centimetres in four minutes. No carbonic acid, nitrous oxide, or other artificial cooling agent is employed either inside or outside the apparatus. With the liquid oxygen obtained, a series of interesting experiments were shown, which, however, were not in themselves new, such as the freezing of ether and alcohol, and the pulverisation of india-rubber after cooling. The expanded gas, after leaving the apparatus by the wide tube shown in the diagram, was led back to the suction pipe from which the pump was drawing. The impulse of the pump thus caused rhythmical variation in the pressure of the expanded gas over the surface of the liquid which had collected, and this in its turn produced a rhythmical variation in the small amount of ebullition visible in the liquid. Dr. Hampson's experiments, performed in the presence of a considerable number of representative men, constitute the first complete demonstration in England of the efficiency of the process of self-intensification of cold produced by expansion alone without the aid of extraneous artificial refrigeration.

It is obvious that the model exhibited admits of modification, both as to size and in some details of arrangement; but this ingenious adaptation of a well-known principle cannot fail to receive important practical applications. In the meantime the results already attained have the highest scientific interest. Among the more immediate consequences, we may look for the liquefaction of hydrogen in such quantities as to admit of the more exact study of the physical properties of this element in the liquid, and perhaps even in the solid state; while following upon this, the attainment of, or approximation to, the absolute zero of temperature cannot be far off.

ANIANUS JEDLIK.

ON the 12th of last December, a month before having completed his ninety-sixth year, Anianus Jedlik, who had for half a century been an active labourer in the field of experimental physics, ended his lengthy career at the cloister of the Benedictine Order, in Györ.

It was a strange sort of an investigator's life that came to a close with Jedlik's death. We scarcely meet with his name in the international literature of natural sciences, and yet he worked a great deal and wrote a great deal; but he totally lacked the ambition to obtain the appreciation of foreign fellow-labourers in his branch of learning, for the results attained by him. To him, his researches in the world of physical phenomena afforded in themselves sufficient enjoyment; and his laboratory work thoroughly satisfied his unpretending nature, which was free from all desire for fame.

Stephen Jedlik, who as Benedictine monk adopted for his monastic name that of Anianus, was born on January 11, 1800, at Szimö, in the county of Komárom (Hungary). He frequented the Latin schools at Nagy Szombat and Pozsony. In 1817 he entered the bonds of the Benedictine Order at Pannonhalma, in 1822 he became Doctor of Philosophy, and in 1825 was consecrated officiating priest.

The talented young priest was intended by his Order for a professor, and so he was employed in teaching natural philosophy successively at Pannonhalma, Györ, and Pozsony. In 1840 he was appointed Professor of Natural Philosophy at the University of Pest.

Jedlik's scientific researches extended to various branches of natural philosophy; nevertheless he turned his attention principally to those physical phenomena which chiefly absorbed the learned men of the time at which he started upon his career, namely, those connected with galvanism and electro-magnetism.

Within the sphere of these, Jedlik succeeded in making two important discoveries, as we can prove with total certainty. But these discoveries now bear the names of others, who happened to make them independently of Jedlik, and hastened to make the scientific world acquainted with them, while he merely laid them before his own pupils.

It was in the first years of his professorship—in 1827-1828—that, upon reading about electro-magnetism in the German periodicals to which he had access, he modified Schweigger's multiplicator in the following manner. He put in the place of the magnetic needle an electro-magnet, and thus, with the aid of a current-commutator, produced permanent rotation.

Jedlik relates, in his modest manner, that he never came upon any mention of such electro-magnetic rotatory apparatus in any of the periodicals or works with which he was acquainted, so that he could not but believe that he was their discoverer. But he kept it to himself, as he had repeatedly experienced that descriptions of apparatus constructed by him after his own original ideas, already existed elsewhere; and so he never thought of sending descriptions of the above to any of the foreign scientific periodicals of which he knew.

Jedlik's other discovery had reference to the fundamental principle of the dynamo-electric machine. In the collection of the physical department of the University of Budapest, there is a machine of very primitive construction, dating, as it appears, from somewhere about the year 1860, and probably the work of some mechanician of Pest, to which are joined directions as to its use in Jedlik's own handwriting.

In the fourth point of these instructions we find clearly defined the fundamental principle of the dynamo-electric engine, which principle Werner Siemens brought before the Academy of Berlin in 1867, and according to which the magneto-electric currents of augmenting force may be developed by means of mechanical force, with the aid of the slight amount of magnetism contained in ordinary soft iron.

Jedlik discoursed with great zest upon his investigations at the meetings of natural philosophers and physicians, in whose publications his dissertations are to be found. Several of his treatises appeared in the publications of the Hungarian Academy of Sciences, which elected him its regular member in 1858.

The topics of some of his more important treatises are as follows: "The Deflection of Beams" (1845); "The Application of the Electro-Magnet in Electro-Dynamic Rotations" (1856); "A Modification of Grove and Bunsen's Battery" (1857); "The Magneto-Motor" (1857); "Concatenation of Leyden Jars" (1863), through which peculiar modification he attained a remarkable degree of effect; "Modification of Fresnel and Pouillet's Interference Apparatus" (1865); "Tubular Electric Collectors" (1867); "Electro-magnetic Undulation Machine" (1868).

With Jedlik there expired one of the typical figures of

the old school of physical experimenters who lacked that most important helper to their investigations—the knowledge of mathematics, but made up for this deficiency through a sort of intuitive perception when, led by a certain imaginative or creative faculty, they were able, with a sure hand, to grasp the very essence of a physical phenomenon.

With the present tendency of physical researches, this class of learned men could scarcely hold their ground; but, on the other hand, we must not disdain these mere experimenters, for they count among their number no less a man than the great Faraday.

AUGUSTUS HELLER.

NOTES.

THE adoption of the metric system by the United States seems to have received a notable impulse during the present week by the action of the Committee of Congress, which has reported in favour of its use by the United States Government in all its affairs except the completion of land surveys now in progress, on and after July 1, 1898, and its general use throughout the country on the first day of the twentieth century, January 1, 1901. The report is the outcome of a movement very early in this Session of Congress.

IN accordance with a resolution of the House of Assembly of Cape Colony, carried last year, a Commission, consisting of the Hon. J. X. Merriman, Dr. Thomas Muir, Dr. David Gill, F.R.S., Mr. Thomas Stewart, and Mr. Charles Currey, has been appointed for the purpose of organising, controlling, and directing the work of geological exploration and survey in the colony. We are informed that the Commission has now appointed the under-mentioned gentlemen to begin the work of surveying and mapping the country:—Geologist, Dr. G. S. Corstorphine; Assistant Geologists, A. W. Rogers and E. H. L. Schwarz. As early as possible the Commission will publish and distribute a bibliography of South African geology.

IT has been decided by the Huxley Memorial Committee to strike a medal for award by the Royal College of Science, London, and possibly for other purposes. The Committee desire to obtain the design for the medal, if possible, by competition. Further particulars will be furnished on application, which must be sent in before May 1 to the Honorary Secretary of the Huxley Memorial Committee, Prof. G. B. Howes, Royal College of Science, South Kensington, S.W.

WE regret to see the announcement of the death of Mr. Charles Chambers, F.R.S., Director of the Colába Observatory. For the following particulars of his career, we are indebted to a long notice in the *Times* of India. Mr. Chambers was born at Leeds, Yorkshire, on May 30, 1834, and was consequently at the time of his demise in his sixty-second year. After finishing his education in his native place, he secured an appointment in the Kew Observatory, which he left in October 1863, to take up the post of assistant to the Director and Chief Superintendent and Electrician of the Indo-European Telegraph Department, Persian Gulf Section. In October 1865, he was temporarily appointed Superintendent of the Government Observatory, Bombay. After acting in that capacity for over two years he was confirmed in the appointment in January 1868, and continued to hold that office till November 1886, when he was given the appointment of Director of the Colába Observatory, which office he was holding at the time of his death. He was elected a Fellow of the Royal Society in 1869. He was also appointed a Fellow of the Bombay University in 1872, and a member of the Syndicate of the same University from 1879 to 1890. His contributions to scientific literature were very numerous, most of them being records and discussions of meteorological and magnetic observations in relation to solar changes.

PROF. N. A. MOOS, of the Elphinstone College, Bombay, has been selected for the post of Director of the Government Observatory at Colaba, in succession to the late Mr. Charles Chambers.

THE Annual Congress of the British Institute of Public Health will be held in Glasgow, from July 23 to July 28.

DR. SAMUEL WILKS, F.R.S., was elected President of the Royal College of hysicians of London, at a meeting held on Monday.

PROF. WYNDHAM R. DUNSTAN, F.R.S., has been appointed Director of the Scientific Department of the Imperial Institute, which has hitherto been under the direction of Sir Frederick Abel. The principal work of this Department is to investigate new or little-known products from India and the Colonies, and to advise in reference to their commercial utilisation. Already much valuable work has been accomplished in this direction. With the aid of an increased grant from the Royal Commissioners of the 1851 Exhibition further additions to the staff of the Department will be made, and the Laboratory, which was fitted up in 1894 with the assistance of a grant from the Goldsmiths' Company, will now be considerably extended.

THE College of New Jersey at Princeton is preparing to send an expedition to Patagonia for the purpose of securing fossils and large game. At a recent meeting of the Board of Trustees of the College, it was decided to change the charter name to Princeton University.

A FEW days ago M. Eugéne Fariot, an engineer of some repute and a worker in aeronautics, one of the siege aeronauts who escaped from Paris in the *Louis Blanc*, died at the age of sixty-eight. e has bequeathed a sum of £4000 to the Société française de Navigation Aerienne, of which he was a member. One half of this sum is to pay the expenses of experiments, and the other half to be funded in the name of the Society; the interest to be expended yearly on its behalf. Consequently, it is expected that an end will be put to the long stagnation in scientific aeronautics in France, owing to the indifference of the public authorities for an art so popular in that country.

FOR more than twenty years, the Sunday Society has been working "to obtain the opening of museums, art galleries, libraries, and gardens on Sundays." As already noted in these columns, the House of Commons on March 10 passed, without a division, a resolution in favour of this object. We are glad now to record that in the House of Commons on Monday, in answer to Mr. Massey-Mainwaring, Mr. Balfour said: "The Government are prepared to open South Kensington and Bethnal Green at a very early date—indeed, almost immediately. Those are museums under the control of the President of the Council. The National Gallery, the National Portrait Gallery, and the British Museum are in the hands of trustees, and correspondence is still going on between the Government and the trustees, though I have no reason to believe that any difficulty need be apprehended as to the final conclusion of a satisfactory arrangement." In fulfilment of this promise, it was announced yesterday that the South Kensington Museum, including the India Museum and Science Collections in the Galleries on the west of Exhibition Road, as well as the Bethna Green Branch Museum, will be open on Sunday next at 2 p.m. and will remain open till dusk.

AN instructive case for the consideration of anti-vaccinationists is reported in Wednesday's *Times*. It appears that the guardians

of the Gloucester Union have for some years persistently neglected to perform their statutory duty under the Vaccination Acts, with the result that they now find themselves responsible for one of the most appalling outbreaks of smallpox which has for a long series of years visited any provincial town in England. During the last seven weeks, the notifications of fresh cases of smallpox in the cathedral city of Gloucester have enormously increased, the number of new cases during the past week being no less than 154, and the disease is still rapidly spreading. The guardians are now endeavouring to stem the disastrous torrent they have let into Gloucester by their non-compliance with the laws of vaccination. About a week since they decided to attempt to undo the mischief of past years by passing a resolution deciding to enforce the compulsory clauses of the Vaccination Acts. It may be stated that the Town Council of Gloucester from the first have done their utmost by isolating the sick in hospital, by disinfecting houses, burning clothes and bedding, and placing relatives of sick in practical quarantine to stay the outbreak. Finding the outbreak gaining, they built extra hospitals, and have now hospitals for 120 patients, but the disease has continued to spread with such virulence that it is quite beyond their power to cope with it. A significant fact is that out of 90 deaths that have occurred in hospital up to March 27, 74 are among unvaccinated persons.

Individual enterprise is not often lacking in British commercial circles. Mr. R. K. Douglas gives an instance of this in the *Times*. He states that the Blackburn Chamber of Commerce have inaugurated a subscription, which now amounts to between £2000 and £3000, to provide sums for the purpose of sending out a commercial expedition to China, whose duty it will be to report on the state of trade in the interior of the country, the price of foreign goods in the native markets, the kinds of goods in demand, and the products and capabilities for trade of the inland districts. So far no assistance has been asked from the Government, and none has been given. But a point has now been reached when that modicum of official support which is necessary to the success of the expedition should be confidently asked for and promptly granted. Mr. Douglas is undoubtedly right in pointing out that if the expedition is not to prove a failure, the Foreign Office should supplement the efforts of the Blackburn Chamber of Commerce by giving it tangible support, and by appointing a member of the Consular Service in China to accompany the expedition on its travels. There should be no difficulty in doing this, and we hope with Mr. Douglas that the Government will give support to an undertaking which has for its important object the further promotion of British trade in the Far East.

Writing with reference to the aurora of March 4, it was suggested by Dr. M. F. O'Reilly, in our issue of March 12, that possibly Röntgen effects might be produced by auroral light. Mr. Donald S. Munro sends us a cutting from the Glasgow *Evening News*, in which he describes an experiment made to test this point. He says: "I put a rapid isochromatic plate in a camera slide, and covered the slide with black paper wrapped round several times, in case of any possible want of tightness in the slide. Several circular and triangular pieces of sheet-iron were placed beneath the paper, and next the lid of the dark slide. On developing, the result was no image. Perhaps, however, some one trying again with a brighter display and a longer exposure might get a result. I did not think of the experiment until the northern lights were beginning to fade, so my plate had only half an hour's exposure."

Statistics relating to the harvest gathered in from the sea around the coasts of the United Kingdom during 1895, are given in a return made to the Board of Trade, and published as a Parliamentary Paper. The statistics relate mainly to fish landed on the coasts of England and Wales, but summarised statements are also given of fish landed on the Scotch and Irish coasts. For purposes of comparison the statistics are given of the sea fisheries of Norway, Holland, France, and Canada. As regards England and Wales, the total value of the fish landed was £5,438,000. The corresponding values for 1893 and 1894 were £5,171,000 and £5,291,000 respectively. For Scotland the total value was £1,830,000, and for Ireland £269,000. In Scotland, during the year 1895, there has been a slight decrease in the quantity and an increase in the value of the fish landed as compared with 1894. In Ireland there was a decrease, both in quantity and value. The aggregate value for the United Kingdom during the year 1895 is £7,537,000, as compared with a total value of £7,260,000 in 1894. The figures for other countries during 1895 are not to hand, but for 1894 the values were:—Norway, £1,272,000; Holland, not accurately known, but probably less than Norway; France, £4,681,000; and Canadian Dominion, £4,317,000.

The report of the Departmental Committee appointed by the Board of Agriculture to inquire into the etiology, pathology, and morbid anatomy of swine fever has been issued as a Blue-book. The following conclusions are stated therein: (1) Bacteriological investigations prove that the cause of swine fever is a specific microbe. (2) Experience and observation prove that swine fever (both in its acute and chronic forms) is communicable from diseased to healthy swine by contact, and also by the agency of persons, animals, and substances which are capable of conveying the infective matter. (3) It has been shown that the pronounced symptoms which have hitherto been looked upon as essential to a correct diagnosis are not always present in the early stage of swine fever, and are almost constantly absent in the chronic form of disease. (4) The Committee regard it as an important outcome of the study of the morbid anatomy of the disease that some animals undoubtedly infected with swine fever presented only minute erosions in the intestinal canal, and that other animals, which had been suffering from either the acute or the chronic form of the malady, but which had recovered, showed only depressed scars which were apt to be overlooked at any but a very thorough *post-mortem* inspection. (5) From the experimental evidence it is concluded that a condition of plugging of the crypts on the ileo-cæcal valve cannot be accepted as an indication of swine fever.

The current number of *Weidemann's Annalen* contains an interesting paper by Herr Lang on the determination of the wave-length of Hertz electric waves. The method employed is similar to Quincke's method of measuring the wave-length of a musical note by arranging the lengths of two tubes which, starting from near the source of sound, are at their other ends brought together, so that the sound which has travelled along one tube interferes with that which has travelled along the other. Herr Lang uses an oscillator of Righi's form, consisting of two spheres. The tubes along which the electric waves have to pass are made of paper lined with tinfoil, and have a diameter of about 6 c.m. In order to detect the electric oscillations, a Branly tube (coherer) was employed. By placing a paraffin cylinder in one of the tubes the wave-length of the electric oscillation in paraffin, and hence the refractive index of paraffin, can also be measured.

The "Handbook of Jamaica" for 1896 is filled with historical, statistical, and general information concerning the island. This present issue contains in an appendix a useful article by Mr. W. Fawcett, Director of Public Gardens and Plantations in Jamaica on the planting and care of woodlands.

A SENSIBLE little pamphlet, entitled "Health Notes for the Seaside" (Whitby: Horne and Son), in which some of the salient facts of the science of hygiene are applied practically to every-day life and holiday seeking, has been written by Mr. A. C. Dutt. The "Notes" contain much good advice on how to make the best use of a brief holiday.

MESSRS. G. PHILIP AND SON have sent us a copy of the special map they have had prepared to illustrate the British and Italian operations in the Eastern Soudan and Red Sea littoral. The map shows the entire course of the Nile from the great lakes to the sea, and the approaches to Khartum from the east coast. Another map published by the same firm, shows on a large scale the present scene of operations in Egypt.

THE fifth part of the second volume of the *Proceedings* of the Imperial University College of Agriculture, Tōkyō, is occupied by two papers, both in German, on Japanese trees in the winter state, illustrated by thirteen plates, and on the shrinking (*Klemmen*) of the Japanese timbers which are most useful for practical purposes.

THE "Hand-list of Coniferæ grown in the Royal Gardens, Kew," just issued, comprises 227 species, with 340 varieties. It has been drawn up with the assistance of Dr. M. T. Masters, and is preceded by a very valuable historical sketch of the nomenclature and classification of the *Abietineæ*, from the pen of Sir Joseph D. Hooker.

A KIND of German *Kew Bulletin* is announced, with the title *Notizblatt des königlichen botanischen Gartens und Museums zu Berlin*, under the direction of the staff of the Royal Garden and Museum at Berlin. It is to be devoted to the botanical interests of the German colonies, to the presentation of results which it is desirable to place promptly before those interested, and to the publication of new species.

WITH the view of bringing together the opinions of persons interested in reptiles, and with the laudable intention of educating people to a kinder feeling for these interesting creatures, *The Vivarium* has been started. The first number has been produced by a lithographic process, but the promoters hope to elevate the contributions to the dignity of print in the near future. The periodical is intended to be the organ of the newly-formed Reptilian Society, and copies can be obtained from the Secretary, Rand Rectory, Wragby, Lincolnshire.

A SIXTH revised edition of Prof. C. Gegenbaur's "Lehrbuch der Anatomie des Menschen" has been published by Engelmann, of Leipzig, in two ponderous volumes. The work was originally published in 1883, and took its place in the first rank among reference books of anatomy. The revisions ensure that the new edition will maintain the high position earned by the original. Another new edition, received during the past few days, is the seconds of "Geology and Scenery of Sutherland" (Edinburgh: D. Douglas), by Mr. H. M. Cadell. The book is a worthy example of a guide-book which has nature for its subject, and is a desirable companion for visitors tc the rocky wilds of Sutherland. Would there were similar volumes for every county in the British Isles. Many instructive diagrams and full-page illustrations are distributed through the pages of the book.

THE Royal Agricultural and Commercial Society of British Guiana may not be progressing so much as it deserves, if progress is counted by an increased roll; but its admirable journal, *Timehri*, the December number of which (vol. ix. part 2) has come to hand, testifies to the existence of a healthy spirit of inquiry, which assists in the progress and development of the great colony with the affairs of which it is chiefly concerned. Among the subjects of papers in the present number are: "Food Adulteration," by Mr. L. M. Hill; "The Relation of Boiling Temperatures in Multiple Evaporation," by Mr. F. I. Scard; "Ethnological Notes from Pirari," by Mr. C. A. Lloyd; "The Materials of the Urali Poison," by Mr. J. J. Quelch; "Some Guiana Parrots," by Mr. C. A. Lloyd; and two articles by the editor, Mr. James Rodway—one on the future of the Negro, and the other on the old boundary of Essequibo. In view of the fact that Venezuela lays claim to the whole of Guiana west of the Essequibo, it is well to call attention to this article, in which Mr. Rodway shows the baselessness of such a claim. The London agent of *Timehri* is Mr. E. Stanford.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. S. C. Fisher; a Silver-backed Fox (*Canis chama*) from South Africa, presented by Mr. C. W. Southey; a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Miss E. S. Young; two Crowned Dricker-Boks (*Cophalophus coronatus*, ♂ ♀) from West Africa, received in exchange.

OUR ASTRONOMICAL COLUMN.

NEW VARIABLE STARS.—The *Harvard College Observatory Circular*, No. 6, announces that an examination of the Henry Draper Memorial photographs of stellar spectra by Mrs. Fleming has led to the discovery of fourteen new variable stars of long period, in addition to those previously announced. The spectrum of the fifth star in the following list is of the fourth type. All of the others have spectra of the third type, having also the hydrogen lines bright, and it was this peculiarity which led to their discovery. The variability has been shown by comparison of a large number of photographs, and the variation has been confirmed in each case by Prof. Pickering.

Constellation.	Designation.	R. A. 1900.	Dec. 1900.	Magnitude.		Date of next Maximum.
				Br.	Ft.	
		h. m.	° ′			1896
Sculptor ...	−39° 16	0 3·6	−39 47	8·9	<12·1	May 25
Columba ...	A.G.C. 6135	5 15·6	−33 48	7·6	11·3	June 23
Canis Minor...	...	7 1·5	+9 1	10·3	<13·7	Sept, 11
Virgo	+5° 2708	12 57·6	+5 43	8·8	9·7	...
Apus	...	14 59·3	−71 40	9·0	<11·4	...
Sagittarius ...	−33° 13234	18 21·4	−33 23	8·2	12·3	July 2
Sagittarius ...	−19° 5347	19 8·1	−19 2	9·7	11·1	...
Sagittarius ...	...	19 8·7	−18 59	9·9	<13·3	...
Pavo	...	19 39·5	−72 1	7·6	12·1	Aug. 29
Microscopium	A.G.C. 28038	20 21·8	−28 35	7·4	8·4	...
Pavo	...	20 47·2	−63 5	9·6	<12·3	...
Grus	−38° 15044	22 19·9	−38 4	8·6	11·0	...
Grus	...	22 19·9	−48 57	7·2	12·3	May 10
Aquarius ...	−16° 6379	23 47·1	−16 25	8·2	9·3	...

COMET PERRINE-LAMP.—The following is a continuation of Dr. Lamp's ephemeris of Comet Perrine-Lamp for Berlin midnight (*Ast. Nach.*, 3341):—

	R.A.	Decl.	Brightness.
	h. m. s.	° ′	
April 3	4 19 25	+42 4·7	0·023
6	24 49	41 36	
9	29 45	41 10·0	
12	34 21	40 48·3	
15	38 39	40 28·4	0·012
18	42 45	40 10·8	
21	46 39	39 55·3	
24	50 23	39 41·4	
27	53 59	39 29·0	0·007
30	4 57 28	+39 18·0	

Mr. Joseph Lunt reports that on March 1, 2 and 3, the comet appeared as a circular nebulosity without tail, but with a bright central condensation, which very gradually faded away outwards. It was as bright as the nucleus of the great nebula in Andromeda, which it somewhat resembled, and was easily seen with a telescope of one-inch aperture. On March 9 the aspect of the comet was greatly changed, a bright stellar nucleus having developed; this was not centrally placed, and gave the comet a fan-shaped appearance.

During April the comet passes from near 58 Persei to a little south of η Aurigæ. In the latitude of London it is circumpolar throughout the month.

SEARCH EPHEMERIS FOR COMET 1889 V.—The following search ephemeris for the expected return of Comet 1889 V (Brooks) is given by Dr. Bauschinger (*Ast. Nach.*, 3334):—

	R.A. h. m. s.	Decl. ° ′	Brightness.
April 2	20 40 24	−24 9	0·17
6	47 3	23 50	0·18
10	53 35	23 31	0·19
14	21 0 3	23 12	0·20
18	6 24	22 52	0·22
22	12 39	22 32	0·23
26	18 47	22 12	0·25
30	24 47	21 53	0·27
May 4	30 40	21 33	0·28
8	21 36 25	−21 14	0·29

The ephemeris is for Berlin midnight, and the unit of theoretical brightness is that on 1889 July 8, the date of the first accurate observation. When last seen in January 1891 by Prof. Barnard at the Lick Observatory, the calculated brightness was 0·08, so that the comet should even now be brighter than when it was last observed; it is, however, not very favourably situated for European observers. During April the motion of the comet is a little north of the line from ψ to ζ Capricornii.

INSTITUTION OF NAVAL ARCHITECTS.

THE annual spring meeting of the Institution of Naval Architects was held last week, commencing Wednesday, the 25th ult., and being carried over Thursday and Friday, the two following days. The new President, the Earl of Hopetoun, who has succeeded Lord Brassey, occupied the chair throughout the meeting.

There was a long list of papers to be read, the following being on the agenda:—

(1) "Watertight Doors, and their Danger to modern fighting Ships," by Captain the Right Hon. Lord Charles Beresford, C.B., R.N.

(2) "Watertight Doors," by Colonel Nabor Soliani, Director of Naval Construction, Royal Italian Navy.

(3) "Some Geometry in Connection with the Stability of Ships," by J. G. Bruhn.

(4) "The Causes of Mysterious Fractures in the Steel used by Marine Engineers as revealed by the Microscope," by A. E. Seaton.

(5) "The Measurement of Feed and Circulating Water, &c., by Chemical Means," by C. E. Stromeyer.

(6) "Salvage Appliances," by J. G. Kinghorn.

(7) "Compound Marine Boilers," by Colonel Nabor Soliani, Director of Naval Construction, Royal Italian Navy.

(8) "Water-tube Boilers," by J. Watt.

(9) "Circulation in Water-tube Boilers," by Prof. W. H. Watkinson.

(10) "The Non-uniform Rolling of Ships," by R. E. Froude, F.R.S.

(11) "A New Theory of the Pitching Motion of Ships on Waves, and of the Stresses produced by this Motion," by Captain A. Kriloff, Professor at the Naval Academy of St. Petersburg.

(12) "Notes on the Carriage of Grain Cargoes," by George Herbert Little.

The paper by Lord Charles Beresford set forth the views of a naval officer on the question of watertight doors. It may be said generally that the piercing of bulkheads has been done at the request, or perhaps more correctly speaking, the insistence of naval officers, who have found it difficult to work their ships with partitions in them not allowing means of ingress and egress from one compartment to the other. Lord Charles Beresford, however, differs from the majority of naval captains, and considers that bulkheads are too much pierced. He would do away with a large number of openings in a ship. He tells us that in the *Magnificent* and *Majestic*, which are the most powerful battleships in the service, and, therefore, in the world, there are 150 compartments in each ship, and 208 doors. Many of these of course are not in positions which are of vital importance, so far as flooding of the ship would be concerned in case of accident. He proposes to do away with nineteen of these doors in the most important part of the ship, and twenty-three would be made smaller, or modified so as to give additional safety in accordance with his proposals. This would undoubtedly add to the safety of the ship, and equally without doubt it would detract from the convenience of those inhabiting it. The latter may seem at first a small matter, but, as was pointed out during the discussion which followed the reading of the paper, convenience is to a large extent a measure of efficiency in action. In fighting a ship it is necessary for the men to move from part to part with great rapidity. This naturally means openings in bulkheads; for if a man, say the chief engineer, in order to get from one part of the vessel to another, has to climb up on deck to surmount a bulkhead, and descend on the other side, time will be occupied in the transition. In the rapid handling of ammunition, also, it is absolutely necessary that direct access should be obtained to various compartments; whilst for bringing coal from the bunkers to the stokehole floors, divisions must have openings made in them. It is also necessary to consider the question of habitability. A ship requires ventilation, otherwise it is impossible to live in her; at present a good deal of space is given to steam fans and air conduits, for this purpose. If bulkheads are to be unpierced, the difficulty of ventilation becomes more pronounced. It will be seen, therefore, that the question of openings in bulkheads, whether fitted with water-tight doors or not, is not of so simple a character as might at first appear. In fact in this element of warship design, as in all others, "compromise" must be the watchword. It is necessary not only for naval officers but for naval architects as well to meet and discuss this matter. Up to the present it has been rather that the naval officer has demanded watertight doors, and the ship designer, or naval architect, has opposed the demand. It is evident, from the discussion which followed the reading of Lord Charles Beresford's and Colonel Soliani's papers, that opinions are divided. It is essential that the matter should be threshed out, and the best compromise, according to our lights, should be adopted.

Colonel Soliani's paper dealt with different forms of watertight door. It was very fully illustrated, and will be a valuable source of reference to shipbuilders and naval architects.

In Mr. Bruhn's paper the question of stability of ships was treated, both in an historical and a mathematical manner. This contribution was read in brief abstract, and there was practically no discussion upon it. It is not one that would bear condensation very readily, and in any case could not be understood without the use of the diagrams which accompanied it. It dealt with the problem of constructing geometrically a set of cross curves of stability for inclinations from 90° to 180°, the corresponding curves from zero to 90° being known. Another section dealt with the determination of the direction in which the centre of buoyancy moves when a ship is inclined in a given direction. Lines of curvature and geodetic lines as curves of buoyancy, relations between the surfaces of buoyancy and flotation, and an extension of Leclert's theorem were subjects also dealt with; whilst the paper concluded with a geometrical construction for finding the length n, or the radius of curvature of the curve of flotation, from the usual information given on metacentric diagrams.

Mr. Seaton's paper was an extremely interesting one, and will prove of great practical value to engineers. As is well-known, the author is the managing director of Earle's Shipbuilding and Engineering Works at Hull. Some time ago part of the shafting of a screw steamer with which he had to do suddenly gave way. This shaft was made of steel containing from 0·2 per cent. to 0·25 per cent. of carbon, and its ultimate tensile strength was guaranteed to be not more than 30 tons, with an elongation of 25 per cent. in 5 inches. Mr. Seaton determined to make an inquiry into the composition of this shaft, and for that purpose it was subjected to chemical analysis. We need not repeat this analysis; it will be sufficient to state that it showed a very high proportion of undesirable elements in the steel. The most interesting part of the investigation was that carried out by Prof. J. O. Arnold, of Sheffield, who prepared micro-sections in the usual way. The chief point of the paper consists in the fact that chemical analysis is shown to be insufficient to give the engineer information as to the value of a given steel used for structural purposes. For instance, sulphur which is objectionable under certain conditions may be present to a considerable extent in a steel casting or forging, but though it may be of no serious moment if in one form, will be conducive to most disastrous results in another form. The chemist, as Mr. Seaton pointed out,

is only able to state the quantity of sulphur present; but whether in a dangerous or non-dangerous form, he is unable to say. Mr. Seaton concludes, therefore, that chemical analysis alone is sufficient neither for steel nor for any other combined metal used by the engineer; while, on the other hand, the microscope reveals the actual structure of the material, and shows most distinctly whether it is a safe or an unsafe one. It appears, therefore, that the use of the microscope is likely to be of the utmost advantage to the marine engineer. We have not space to give the details by which Mr. Seaton supports his contention. The subject, however, is one well worthy of attention on the part of engineers, and scientific experts who work for them.

Mr. Stromeyer's paper was also one of interest. He proposes to measure the quantity of water either fed into a boiler, or passing through the condenser, by chemical means. A measured quantity of salt water is slowly injected, say into the condenser of an engine while at work; subsequently a chemical analysis for salt is carried out, both on a sample of sea-water and on a sample of the water to be measured. Their relative salinities would then give the quantity of water pumped, or the amount of steam condensed for any given period. The method is one which will probably be useful for estimating the quantity of circulating water used by the marine engineer, as it is capable of being applied to large quantities of flowing water with comparative facility. For the smaller volumes of water used for feed, which can be passed through pipes of moderate dimensions, the water-metre would, we think, be preferred by the majority of engineers; although, perhaps, the measuring-tank would command the greater confidence than either.

Mr. Kinghorn's paper, on salvage appliances, was of considerable practical interest. It referred to a new system of wreck-raising which has been evolved by certain salvage agents and marine engineers of Liverpool. This country is lamentably deficient in wreck-raising facilities, a fact which has been proved by the resource that has been had to foreign "wrecking" companies, when vessels of exceptionally large size have had to be raised. The case of the battleship *Howe*, at Ferrol, which was lifted by a Scandinavian company, and of the Atlantic liner *Eider*, wrecked on our own coast, and lifted by the same company, are instances in point.

The only evening sitting of the meeting, which was held on Thursday, the 26th ult., was devoted to the great water-tube boiler question, which is now agitating the marine engineering world. Of the three papers set down for reading, that of Prof. Watkinson was by far the most important. Colonel Soliani proposed a combination of fire-tube and water-tube boiler, which did not meet with universal approval during the discussion. Mr. Watt described certain experiments that he had made many years ago, and which could hardly be described as crucial. Prof. Watkinson attacked the great problem of circulation, the vital question certainly in water-tube boilers, and also to a far greater extent than has been supposed, in boilers of the shell, or fire-tube class. The circulation of water and steam in a water-tube boiler involves some very nice questions in physics. Its study affords a good opportunity for those highly skilled in physical science to assist the engineer in arriving at definite conclusions as to what causes govern the flow of water and steam in pipes subjected to heat. There were three types of boiler chiefly dealt with by Prof. Watkinson. The Belleville boiler, a French invention, which has now been in use for a number of years. It consists of a series of pipes of comparatively large diameter, say four inches to five inches; these are arranged in a continuous zigzag form, and subjected to the heat of the furnace; the water flows upward through this serpentine course, steam being generated in its course, and that water which is not converted into steam flows down external pipes, and then again passes into the bottom of the steam-generating pipes. In this way a continuous circulation is kept up. The distance the water has to travel through, from one end of the serpentine to the other, is considerable. The various lengths of pipe are not much inclined from the horizontal, and the sudden bends at the ends of each pipe tend to check the flow. It is believed that for this reason the Belleville boiler will not stand forcing—that is to say, only moderate quantities of coal can be burned to each unit of grate surface. For if rapid evaporation be attempted, the tubes are apt to be denuded of water. Judging by the recent trials of H.M.S. *Sharpshooter*, there would appear to be some truth in this contention. How far it applies, however, is a matter which experiment alone can reveal, and the results of such experiments, even if made, are not yet available so far as we are aware.

The other two kinds of boiler dealt with were of what is known as the "express" type—that is to say, they are boilers which will bear forcing, so that large quantities of fuel can be burned in a given time, and the rate of evaporation thus made very high. These are the well-known Thornycroft and Yarrow types of boiler, which have been so successfully applied to the torpedo-boat destroyers, which have given such remarkable results of late, in the matter of quick steaming. Although both the Yarrow and Thornycroft boiler have small tubes, say about one inch in diameter, which are comparatively short in length, each tube connecting directly with the top and bottom vessel, yet the two types have fundamental points of difference. The Thornycroft boiler has outside down-comers and bent tubes which discharge into the top drum above water. The Yarrow boiler has straight "drowned" tubes. These expressions require some further explanation. Each boiler consists essentially of a top drum or steam vessel, and two bottom drums or wing cylinders. Looked at in sectional elevation, these three drums form the points of a triangle standing on its base. The sides of the triangle are composed of the steam-generating tubes; the base is composed of the fire-grate. The products of combustion ascend from the grate amongst the tubes, and pass off to the furnace. In the Thornycroft boiler the outline formed by the three cylindrical vessels, and the connecting steam-generating tubes, is not strictly triangular, as the tubes are bent, as already stated. This bending enables them to be inserted into the top drum above the water-level carried into the latter. In the Yarrow boiler, the straight tubes pass in a direct line from the bottom vessels to the top drum, and therefore enter the bottom part of the latter, and, consequently, are below the water-level.

We will first trace the course of circulation of water in the Yarrow boiler. As there are several rows of tubes on each side of the furnace, those on the inside are naturally subjected to the greater heat. In them, as steam is first generated, the bubbles of steam rise, and water flows with them. To make up the deficiency thus caused in the content of the tube, water flows down the back tubes furthest from the fire, into the bottom vessel, which is common to all tubes on that side of the furnace, and then ascends those tubes where steam has been generated. In this way a continuous circulation is kept up. In the Thornycroft boiler this cycle cannot exist, as the tubes deliver above water, therefore special down-comer tubes have to be fitted; these enter the top drum below the water-level. Circulation takes place as follows. When the hot gases ascend among the bent steam-generating tubes, steam is generated. The tubes being small, it forces upward a certain quantity of water, which then falls into the top drum, and flowing down the downcomers, is able to rise again in the generating tubes to make up the deficiency. Circulation is, of course, due to the difference in specific gravity of the upward and downward columns of water in the generating tubes, and the down-comers, respectively. For some time past controversy has ranged between two schools—one favouring drowned tubes and anti-down-comers, the other undrowned tubes and down-comers, each maintaining that boilers constructed according to their views have most efficient circulation. Prof. Watkinson's paper dealt with this question, but no final opinion was expressed as to the respective values of the two types of boiler. The Professor had brought from Glasgow the glass model boilers with which he had made a number of experiments. Unfortunately, when he attempted to repeat these at the meeting, the breakage of tubes prevented him from carrying out his full programme. This is much to be regretted, as the experiments are of a very interesting nature. It is to be hoped that at no distant date Prof. Watkinson will have an opportunity of repeating them.

The last day of the meeting was devoted to two papers on pitching and rolling of ships. Mr. Froude's paper was practically a reply to one recently contributed by M. Émile Bertin, the eminent French naval architect, at the last meeting of the Institution; which in turn was a continuation of a paper by the said author read at a previous meeting. Without referring at length to these two papers it would be useless to attempt to give the substance of Mr. Froude's contribution, even if we had space to do so. It may be said, however, that Mr. Froude does not agree generally with M. Bertin. What the points of disagreement are, it would be impossible to explain without the aid of many diagrams, upon which the author relied for making his explanation clear. We must therefore refer our readers to the

Transactions of the Institution for information upon this intricate but extremely interesting subject.

Captain Kriloff's paper was of a completely mathematical character, and indeed was of far too abstruse a nature to follow during the reading. It depended on an appendix of many pages containing columns of figures which would require carefu study to master.

Mr. Little's paper was of practical interest to those concerned in the carriage of grain.

The proceedings were brought to a close by the usual votes of thanks.

The summer meeting this year is to be held in Hamburg during the early part of June. Extensive preparations have been made for the reception of members, and there is no doubt the meeting will be of quite an international character. The success of last year's meeting in Paris has encouraged the Council to go abroad again.

It may be added that the Institution is increasing in numbers at a rapid rate, there being a greater addition to the roll of membership at this meeting than has ever before taken place.

RECENT WORK WITH RÖNTGEN RAYS.

SEVERAL important communications referring to work upon Röntgen rays have come before our notice during the past week. While some experimenters are perfecting the methods so as to develop the capabilities of the rays, others are investigating the physical characteristics pertaining to them, and in both directions of work clear advances have been made since our last eclectic statement of the contributions to the subject founded by Röntgen's discovery.

Prof. Alfred M. Mayer, of the Stevens Institute of Technology, has sent us the following account of experiments carried out by him on the polarisation of Röntgen rays.

"Of the remarkable properties of the Röntgen rays, the one of the greatest interest is that these rays are not polarisable; for this property shows that these rays, unlike those of light, are not propagated by vibrations transverse to the direction of their progress. To decide conclusively this point certain properties, shown by Röntgen's experiments, must be possessed by the substance which is to act on the Röntgen rays, viz. (1) a low density; (2) the substance must be very thin, and yet give complete polarisation to transmitted light. These two properties are eminently peculiar to herapathite, an iodo-sulphate of quinine. Its density is only 1·8, and crystals of herapathite of only 0·05 mm. in thickness, with their axes crossed at 90°, entirely obstruct the incident light, so that their crossed portions appear intensely black.

"Six discs of glass, 0·15 mm. thick and 25 mm. in diameter, were covered with crystal-plates of herapathite crossing one another at various angles. Where they crossed at right angles they gave a black field. These discs were fastened to the surface of a screen of compressed brown paper, which was found to be impervious to the actinic action of a powerful arc light acting during two hours, and placed 1 foot in front of the screen; the latter covering a sensitive photographic plate. On this screen were also placed three discs of the same glass, overlapping one another, so that 1, 2, and 3 thicknesses of the glass had to be traversed by the X-rays before they reached the photographic plate. These discs served as standards with which to compare the action of the X-rays on the discs covered with herapathite. On the same screen was also placed a square of yellow blotting-paper, ⅜ mm. in thickness, having on its surface superposed herapathite crystals from two to four layers deep.

"This screen so prepared, and covering a sensitive plate, was exposed to the radiations of the Crookes' tube; in the first experiment for half an hour, in the second for one hour, and in the third for two and a half hours. On developing these plates there was not the slightest trace of the presence of the herapathites. The photographs of the glass discs had not the slightest mottling on their surfaces. Their surfaces appeared throughout to the unaided eye, and also when examined with a magnifying glass, with a uniform illumination and grain throughout. The herapathite, of the thickness used in these experiments, does not appear to screen at all the X-rays; for all the discs carrying it appeared exactly alike, in illumination and in grain, to the photograph of a similar disc having nothing on its surface. But the action of the rays on the square of blotting-paper carrying the herapathites showed this in a more conclusive manner; for where this paper covered the photographic plate nothing was visible, except by the most careful scrutiny, and with the most favourable illumination, and then a mere ghost of the paper could be detected, but with no traces whatever of the herapathites.

"These experiments appear to have shown conclusively what Röntgen found by his experiments; viz. that the X-rays are not polarised by passing through doubly-refracting media."

At a recent meeting (March 3) of the Dublin University Experimental Science Association, Dr. J. Joly, F.R.S., described experiments made by him on the "Lenard-Röntgen" rays. He has found that the rays are reflected at the surface of mercury, lead, glass and wood. A photographic plate was enclosed in a light-tight carrier of millboard, upon the outside of which a copper ring was attached. This was exposed in the geometrical shadow of a thick lead plate to rays which entering a slot in the plate were reflected at the surface of mercury. An exposure of over an hour gave the shadowgraph of the ring. The position of this upon the plate indicated that the rays had approached from the direction of the reflecting mercury surface. Removing the dish of mercury, a much fainter image was obtained apparently from rays reflected from the wood beneath.

If the rays are received upon the carrier after passage between two parallel lead plates, the dark band formed upon the sensitive plate will be found to be bordered by heavy black lines. This was traced to a very complete reflection at grazing incidence to the lead plates, corresponding to the manner in which light is reflected at grazing incidence. A photographic plate exposed to light passing between the lead plates shows, in fact, a similar dark border; substituting glass plates for the lead, similar effects were obtained. This marked grazing reflection rendered it possible to concentrate the rays to an imperfect focus by causing them to pass through a conical tube of lead open at both ends, when a strengthening of the effects was formed on exposing at the narrow end of the cone.

Before the Royal Society on March 19, Lord Blythswood described some experiments which indicate that the X-rays can be reflected. He placed a vacuum-tube, A (Figs. 1-2), behind a lead screen, B B, 18 in. × 12 and ⅛ thick. The screen had a 2-in. hole in it with a 2-in. pipe attached; 4 in. from the vacuum-tube was placed a speculum-metal mirror D, 4 in. × 2½, at an angle of 45° with the lead screen; 4 in. from the mirror was a light-tight zinc box, E, with aluminium window, F; inside came first the objects, G, stuck on to a black cardboard, H, then I, the photographic plate. The following objects were photographed in about twenty minutes: (1) Some brass clock wheels. (2) A screw-cutting gauge. (3) Two lead discs. (4) The mirrors, being two pieces of speculum-metal used by Lord Blythswood to divide upon.

Two other papers were read before the Royal Society at the same meeting. In one of these, Mr. R. Erskine Murray described experiments made in the Cavendish Laboratory of the University of Cambridge, at Prof. J. J. Thomson's suggestion, in order to find whether the contact potential of a pair of plates of different metals is in any way affected by the passage of the Röntgen X-rays between the plates.

The vacuum bulb and induction coil for the production of the rays were enclosed in a box lined with metal, so that the plates and the apparatus used in measuring their contact potential difference should be screened from any direct electrical disturbances. At one side of the box there was a circular hole of about 3 cm. in diameter. The vacuum bulb was placed just inside this hole, and directed so that the rays should stream out through it in a direction perpendicular to the side of the box. In some experiments this hole was closed by a tinfoil screen, which allowed a large proportion of the rays to pass out while shutting in ordinary electrical disturbances. The plates whose contact potential difference was to be measured were placed at a short distance outside the box, in such a position that the rays could fall on them.

To measure their contact potential, Mr. Murray used the null method described by Lord Kelvin in his paper given to the British Association in 1880. In this method the value of the contact potential is found by measuring the amount of the counter potential which has to be applied to the pair of plates to reduce the potential difference between their opposing surfaces to zero. The counter potential introduced to effect this annulment must obviously be equal and opposite to their contact potential difference. Hence the numerical value of the latter is simply

that of the applied counter potential, but is of opposite sign. The plates were of zinc and tinfoil, the latter being mounted on thin ebonite to keep it flat. They were placed parallel to one another at a small distance apart, so that the rays fell perpendicularly on the back of the tinfoil plate, passed through it and the air space between them, and were absorbed by the zinc. The tinfoil plate was insulated and connected to the insulated quadrants of a Kelvin quadrant electrometer. The zinc was uninsulated, and was connected to the uninsulated quadrants of the electrometer. This plate was movable in a direction perpendicular to its plane, and could thus be drawn away from the tinfoil. If there was any electric potential difference between the opposing surfaces of the two plates, further separation caused a change in it which, reacting on the electrometer, deflected it.

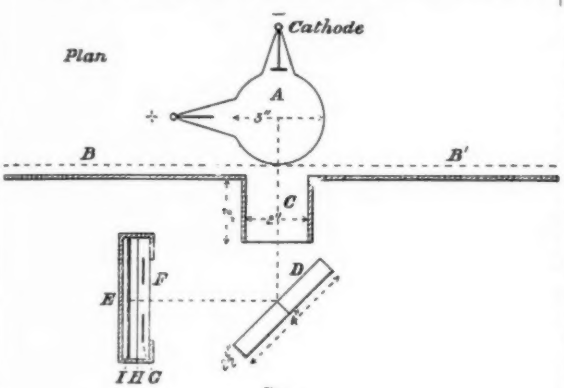


FIG. 1.

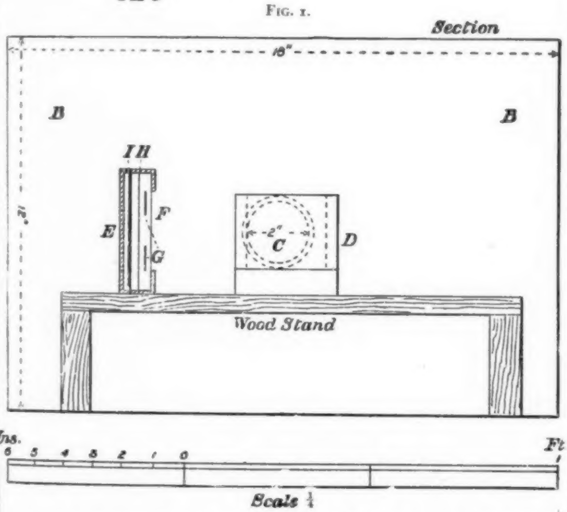


FIG. 2.—A, vacuum tube; BB', lead plate, 18 in. × 12 in. ⅛ in. thick; C, hole 2 in. diameter. Pipes 2 in. diameter × ⅛ in.; D, speculum-metal mirrors; E, zinc box, 4 in. × 4 in., 1 in. deep; F, aluminium window; G, objects; H, black cardboard; I, photographic plate.

Experiments conducted with this arrangement led Mr. Murray to conclude that (1) the influence of the rays on the zinc and tinfoil plates does not cause any direct or sudden change in their contact potential, but that (2) the air through which the rays pass is temporarily converted into an electrolyte, and when in this condition forms a connection between the plates which has the same properties as a drop of acidulated water, namely, it rapidly reduces the potential between the opposing surfaces of the plates to zero, and may even reverse it to a small extent.

It is pointed out that this electrolytic property was found by Lord Kelvin ("Electrostatics and Magnetism," Art. xxiii, §§ 412—414) to be possessed by the fumes from a burning spirit lamp. In both cases its cause is probably the same. It is, no doubt, due to a want of electrical equilibrium among, and a partial dissociation of, the molecules of the gas.

In the third of the Royal Society papers referred to in the foregoing, Mr. C. T. R. Wilson gave an account of experiments made to determine the effect of Röntgen rays on cloudy condensation. The author has previously shown that cloudy condensation takes place in the absence of dust when saturated air suffers sudden expansion exceeding a certain critical amount. He now finds that air exposed to the action of Röntgen rays requires to be expanded just as much as ordinary air in order that condensation may take place, but these rays have the effect of greatly increasing the number of drops formed when the expansion is beyond that necessary to produce condensation. It is concluded that when the Röntgen rays pass through moist air they produce a supply of nuclei of the same kind as those which are always present in small numbers, or at any rate of exactly equal efficiency in promoting condensation.

At the Royal Dublin Society, on March 18, Mr. Richard J. Moss read a paper on the Röntgen X-rays. The mixed gases obtained by the electrolysis of hydrochloric acid were submitted to the action of X-rays. The apparatus employed was similar to that devised by Bunsen and Roscoe for their "Photo-Chemical Researches" (*Phil. Trans.*, vol. cccxlvii. p. 355). Every precaution was taken to ensure that the hydrogen and chlorine were in atomic proportions, and free from impurity. It was found that the X-rays, at a distance of 5 centimetres from the Crookes' tube, caused no combination of the hydrogen and chlorine. The combination of 0·1 per cent. of the volume of gas operated upon could not have escaped detection. The X-rays from the Crookes' tube employed were sufficient to produce fluorescence in a crystal of lithium rubidium platinocyanide at a distance of 2 metres. The examination of a series of crystalline platinocyanides showed that lithium rubidium platinocyanide emitted the brightest light under the influence of the X-rays. The same order of luminosity was observed with ultra-violet light as with X-rays; and the colour of the fluorescence is similar whether excited by X-rays or by ultra-violet. Crystals of platinocyanides which exhibited yellow and green fluorescence under the influence of the X-rays, behave as bodies opaque to those rays when photographed. Potassium platinocyanide exhibits blue fluorescence, and if a crystal of this salt, separated from the sensitive plate by a sheet of white paper, be submitted to the action of the X-rays, it behaves as a luminous body and does not throw a shadow. The fluorescent light excited by the X-rays in this salt, acts more powerfully upon the sensitive plate than the direct X-rays.

Dr. John Macintyre has sent us an account of a further study and comparison of fluorescent screens. He says:

"I have tried several screens of calcium tungstate as recommended by Mr. Edison. The insoluble amorphous precipitate is fluorescent, but I have had it prepared in the crystalline form from two different sources; in both cases the screens gave much better fluorescence, and consequently better images. Messrs. Baird and Tatlock prepared the one form of crystalline salt, which was larger in the crystals than that prepared for me by Mr. I. Frank Bottomley. As there seems to be some difficulty in obtaining the crystalline form, it may be of interest to say tha the latter gentleman prepared it according to the method of N. S. Manross ("Liebig's Annalen," vols. 81–82). The method consisted in fusing together the anhydrous sodium tungstate and calcium chloride, the latter in excess The sodium chloride and excess of calcium chloride are dissolved out, and crystalline calcium tungstate is left behind to be filtered off and dried. The crystals are a mixture of needles and octahedra, the latter only recognisable through the microscope.

"As far as I have been able to judge from the preparations given to me, potassium-platino-cyanide is the best salt. Of course, Mr. Edison may have a better method of preparing the crystals. With greater experience in screens, I am inclined to think that success depends very largely upon the way in which they are prepared. The paper or glass covering must be thickly and evenly coated. I have had an excellent screen prepared with the barium salt as well.

"My experiments have mainly been with the human skeleton; I have now seen shadows of all the bones and joints of the extremities, and what is more important, by placing the tube in the proper position I have seen distinct shadows of the spinal column and ribs of a man. The head is easily penetrated, and for surgical purposes all we now require in order to obtain greater

definition in any part of the skeleton, is a more powerful source of X-rays; in other words, a step further in the preparation of Crookes' tubes. Even now the shadows obtained are good enough for many surgical purposes."

One of the most important discoveries in the new field of investigation is that certain phosphorescent substances emit rays capable of penetrating opaque materials and producing photographic effects. M. Henri Becquerel's experiments in connection with this matter have formed the subject of several valuable communications to the Paris Academy of Sciences, and have been referred to in our abstracts of the *Comptes rendus*, as well as in a brief note. We propose to give a full account of his work in a subsequent number of NATURE.

Mr. A. Hutchinson has sent us, under date March 23, the following account of experiments carried out by him in the Mineralogical Museum, Cambridge:—

"During the past few weeks I have found that quite a number of inorganic substances fluoresce when exposed to the action of the Röntgen rays; thus the following minerals all become more or less luminous, viz. diamond fluor-spar, apatite, autunite, scheelite, and a number of lead compounds, including cerussite, matlockite, anglesite, lanartrite, phosgenite; also lead chloride, lead iodide, lead glass, uranium nitrate and uranium glass. The fluorescence produced in most of these substances is very weak, but autunite, uranium nitrate and uranium glass, cerrussite, some specimens of fluor spar, and some diamonds become fairly bright. The most effective substance which I have so far examined is, however, scheelite, the native tungstate of calcium. Colourless crystals of this mineral phosphoresce brilliantly under the action of the X-rays, the glow continuing for some seconds after the current is switched off, and when powdered they afford a screen which is at least as bright, if not brighter, than one prepared with barium platinum cyanide. It seems very possible that this substance may be 'the properly-crystallised' calcium tungstate of Edison's telegram, quoted in NATURE of March 19.

"It is, perhaps, interesting to note also that uranium nitrate, uranium glass, and the minerals autunite and torbernite are all capable of producing the remarkable effects discovered by M. Becquerel. Thus I have found that the radiations given out by uranium nitrate, when exposed to daylight, in an ordinary room are capable in twenty-four hours of penetrating sheets of aluminium 0·5 mm. thick, and I have obtained a shadow photograph of a coin by placing it on a plate, thoroughly protected from sunlight by light-tight envelopes, and covering it with a slab of uranium glass. This arrangement was allowed to stand near a window for a day; on developing the plate a distinct outline of the coin was found."

A decided step in advance in the application of Röntgen photography to medical science is marked by illustrations in the current issues of the *British Medical Journal* and the *Lancet*. The former journal contains a striking double-page plate of the skeleton of an infant, reproduced from a photograph by Mr. Sydney Rowland, and demonstrates at once the ability to portray the deep visceral region of the body by means of Röntgen rays. Mr. Rowland remarks that although no disease was present in the body of the child, the picture is none the less interesting from a scientific and medical point of view as being the first step towards the application of the method to the diagnosis of spinal and other deep affections. The photograph was obtained in fourteen minutes, and the age of the child was three months. The tube employed was the new focus tube, and it was placed some eight inches from the surface of the body so as to obtain sufficient spreading to cover the plate. It is pointed out that the positions of some of the soft organs are indicated on the picture; thus the heart and lungs are clearly silhouetted, and curiously enough the coils of intestine; while a clear space above them exhibits the place occupied by the stomach. A striking feature is that only the ossified portions of the bones in the arm and hand produce definite shadows, the undeveloped parts of the bones being but faintly visible.

The *Lancet* referred in the issue of March 21 to a photograph obtained through the body of a dead monkey, into whose kidney a biliary and uric acid calculus had been previously inserted. The current issue contains a plate reproduced from this photograph, and showing the spinal column and ribs with great clearness. The biliary calculus can hardly be distinguished from the kidney substance, but the uric acid calculus shows very clearly. The kidney itself is almost transparent to the rays, though not absolutely so.

In a letter communicated to the *Electrician*, Prof. G. M. Minchin gives a summary of the conclusions to which he has been led with reference to the discharge of electrified bodies by the X-rays. The generally accepted opinion is that the X-rays discharge negative electricity from all bodies with great rapidity, and positive more slowly, leaving every body finally with a positive charge. Prof. Minchin, however, finds that "the X-rays charge some bodies positively and some negatively, and whatever charge a body may receive by other means, the X-rays charge it, both in magnitude and sign, to the charge which they independently give to the body." While gold, silver, copper, platinum and iron are all charged positively by the X-radiation, sodium, magnesium, tin, lead and zinc are charged negatively, the effect being in the case of some of these metals much more marked than in the case of the metals that become positively charged. Antimony appears to be almost neutral. Prof. Minchin considers that these observations tend to support the view that the X-rays are undulatory in character, and not of the nature of kathode rays.

Prof. Oliver Lodge writes to the *Times*:—"It may be worth just putting on record that during the past week I have seen fluorescence excited by Röntgen rays after they had penetrated the bodies of two men standing one behind the other in their clothes. Also, that we have succeeding in radiographing the details of a damaged vertebra in the spine of an adult patient at the Northern Hospital, Liverpool, with an exposure of half an hour; and have found a 'Murphy-button' in the intestine of another adult at the Liverpool Royal Infirmary with an exposure of ten minutes. A 'focus-tube' and a powerful ordinary induction coil were the means used."

Six good photographic reproductions accompany an article on Röntgen photography contributed by Mr. J. W. Gifford to *Knowledge*. One of the pictures of a mouse, and another of a sparrow, obtained on February 28, clearly locate the internal organs.

Finally, a number of important papers are referred to in the abstract of the *Comptes rendus* which appears in another column.

REPORT ON THE USE OF ANTITOXIN IN DIPHTHERIA.

A DETAILED report on the use of antitoxic serum in diphtheria, at the hospitals of the Metropolitan Asylums Board, has just been issued. It exhibits the results obtained during the year 1895 in all the six hospitals in which cases of diphtheria were treated, and is a most valuable testimony to the efficacy of the new treatment. From the summary of the report given in the *Times* we derive the subjoined general statistical results and conclusions.

Antitoxin was administered in rather more than three-fifths of the total number of cases admitted into the hospitals, and those for the most part representing the severer types of disease. The value of results obtained will be seen by taking the whole of the figures for 1895 and contrasting them with those of 1894, or rather with the first ten months of that year, previous to the introduction of antitoxin. This gives the following results:

Year.	Cases.	Deaths.	Mortality per cent.
1894	3042	902	29·6
1895	3529	796	22·5

The reduction in mortality of 7·1 per cent. below that of 1894—the lowest previously recorded in any year—must be fairly attributed to antitoxin, because nothing else was changed in the treatment; the average severity of the disease was about equal in the two years, and the proportion of juvenile, that is unfavourable, patients was somewhat larger in 1895 than in 1894. It may be added that diphtheria in both years alike means diphtheria as clinically, not bacteriologically, diagnosed. The essential conditions, therefore, were the same in the two periods. Had antitoxin been used in all cases in 1895, instead of in three-fifths only, the comparison would have been more symmetrical, but the numbers are sufficiently large to make it quite valid; and in this connection it is worth noting that those individual hospitals which made least use of the drug show the highest rate of mortality and the smallest reduction on their previous records. The broad conclusion reached is that in the year 1895 antitoxin saved 250 lives in London.

A complete examination and discussion of the statistics, leads to the following conclusions:—

The improved results in the diphtheria cases treated during the year 1895, which are indicated by the foregoing statistics and clinical observations, are:—

(1) A great reduction in the mortality of cases brought under treatment on the first and second day of illness.

(2) The lowering of the combined general mortality to a point below that of any former year.

(3) The still more remarkable reduction in the mortality of the laryngeal cases.

(4) The uniform improvement in the results of tracheotomy at each separate hospital.

(5) The beneficial effect produced on the clinical course of the disease.

A consideration of the foregoing statistical tables and clinical observations, covering a period of twelve months and embracing a large number of cases, sufficiently demonstrates the value of antitoxin in the treatment of diphtheria.

It must be clearly understood, however, that to obtain the largest measure of success with antitoxin it is essential that the patient be brought under its influence at a comparatively early date—if possible not later than the second day of disease. From this time onwards the chance of a successful issue will diminish in proportion to the length of time which has elapsed before treatment is commenced. This, though, doubtless, true of other methods, is of still greater moment in the case of treatment by antitoxin.

Certain secondary effects not infrequently arise as a direct result of the injection of antitoxin in the form in which it has at present to be administered, and, even assuming that the incidence of the normal complications of diphtheria is greater than can be accounted for by the increased number of recoveries, we have no hesitation in expressing the opinion that these drawbacks are insignificant when taken in conjunction with the lessened fatality which has been associated with the use of this remedy.

We are further of the opinion that in antitoxin serum we possess a remedy of distinctly greater value in the treatment of diphtheria than any other with which we are acquainted.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The next examination for the diploma in agricultural science and practice will begin on July 6, 1896. Names of candidates should be sent to the Registrary of the University on or before Monday, June 22, 1896. The examination is open to persons who are not members of the University as well as to members.

WE learn from *Science* that the Bill establishing a National University of the United States has been reported favourably by the Senate Committee. It grants a charter to the University, provides for its government, grants it the ground in the city of Washington designated by President Washington as a site for a national university, and appropriates 15,000 dols. for the fiscal year ending on June 30, 1897, and 25,000 dols. for the year following.

WE offer our best wishes to *Education, Secondary and Technical*, the new weekly journal of combined educational interests, which has taken the place of the *Technical World* and *Science and Art*. There is much for such a periodical to do, and the combination of technical and secondary interests in education is certainly one that makes for advancement. As the journal is the official organ of the Incorporated Association of Head Masters, the Association of Directors and Organising Secretaries of County Councils, the National Association of Manual Training Teachers, and the Recreative Evening Schools Association, it should not lack support.

AT a meeting of the Technical Education Board of the Stourbridge district, held on Tuesday, March 17, the Chairman announced that promises amounting to £540 had already been received towards the building fund for the proposed new technical schools in that town. Other promises, where the actual amount has not been specified, will materially increase this total. The sum at present assured enables the Committee to claim a grant of £600 from the Worcestershire County Council. It is not intended that a site should be chosen and active steps taken until the sum of £2000 is in hand.

AT the meeting of the Association of Chambers of Commerce, held at the Hôtel Métropole, London, on Wednesday, the 25th ult., the following resolution, proposed by the London Chamber, was agreed to:—"That this association views with interest the report of the Royal Commission on Secondary Education, and, while it regrets the exclusion of commercial representation from its membership, suggests that its recommendations be carefully considered, and, so far as they commend themselves, put into practice at an early a date as possible. That the Executive Council be recommended to take an early opportunity of urging upon Chambers of Commerce the necessity of keeping in touch with their local County Councils, in order that such Chambers may secure representation upon any local educational authority which may be called into existence by legislation, and thus obtain the due consideration and provision of industrial and commercial education recognised by the Royal Commission as falling under secondary education."

THE Paris correspondent of the *British Medical Journal* reports that the French Senate is about to name a Commission to examine the New University Law, which has been voted unanimously by the Lower Chamber. In the last bulletin of the Minister of Public Instruction of grants, receipts, and register of students in the French faculties during the ten years 1884 to 1895, it is stated that in 1884 a total of 14,000 students were registered in the different faculties, and in 1895 24,000. In 1884 Government granted to the faculties £460,000. In ten years £104,000 has been added, making a total of £564,000. The faculties received from students' fees ten years ago very nearly £160,000, and last year a little more than £260,000. In 1884 each university student cost £21 18*s*. 4*d*. In consequence of the considerable afflux of pupils, the cost to the university for each student is now £11 0*s*. 10*d*. The French universities consider that Government does not treat them with sufficient liberality. In support of their plea the grants to the German universities are quoted; these are £400,000 more than the amount granted by the French Government. No hope is entertained that by Government help the French universities will rival the German universities in organisation of laboratories, libraries, and general excellence.

A STRONG Committee has been formed to organise some permanent memorial to perpetuate the memory of the late Rev. William Rogers, who did good pioneer work for education. It is proposed that the funds obtained should be used in connection with the St. Thomas, Charterhouse Schools, where Mr. Rogers worked to improve middle-class education, and assisted to develop the present system of elementary education. The introduction into primary schools of the practical study of science and art was commenced there. Dr. Gladstone, F.R.S., in giving evidence before a Special Committee of the London School Board, once said:—"Prof. Sylvanus Thompson told me that the only elementary school in London from which the Finsbury College could draw youths qualified for technical classes, was that of St. Thomas, Charterhouse, where a good deal of scientific instruction is given, and the boys are encouraged to make their own apparatus." The great aim has been to make the institution self-supporting, and this to a great extent has been accomplished; but the providing of special and costly science apparatus—of effecting expensive structural alterations—render it necessary to occasionally apply for extraneous aid, so that Mr. Rogers' work may not be allowed to languish. The late founder, before his serious accident, was intent upon helping the School Committtee to raise funds by means of which the building could be modernised, and a playground added, and additional science accommodation provided. Subscriptions for these purposes, made payable to the account of the Rogers Memorial Fund, will be gladly received by either of the Hon. Secretaries, St. Thomas, Charterhouse Schools, Goswell Road, London, E.C.

SIR JOHN GORST introduced the Education Bill of the Government into the House of Commons on Tuesday. The Bill is a great measure of educational decentralisation. It provides for the establishment of a paramount educational authority in every county and county borough. This is to be the channel through which public money is to reach the schools. It is to supplement and not to supersede existing educational effort, and it is to be a sort of separate Education Department for each county and county borough. Sir John Gorst also proposes that the education authority shall be the county council acting through a statutory educational committee, and the number and composition of this committee is to be left entirely in the discretion of the county council, subject only to the condition that the majority of its members must be also members of the council. The in-

tention is to decentralise the administration of school grants by the Education Department, and to throw upon those bodies the duty of administering the Parliamentary grant. Should the Bill become law, the general inspection of schools will be undertaken by the county authority, and the Committee of Council—the central government—will only have inspectors who will visit the schools from time to time in order to see that the county education authority is properly fulfilling its duties, and that the education is up to the proper standard. It is proposed to hand over to this committee the powers of the county council under the Technical Instruction Act, 1889. The money received under the Local Taxation Act, 1890, will be specially applicable to secondary education, and will be administered by the education authority, and may be accumulated. It is hoped that the Bill will create a system under which all those parts of a county in which there are public schools will be connected with and under the authority of the county education authority, and will be maintained out of the general county rate. As regards secondary education, the new authority will be able to aid schools out of the money at its disposal and to establish them; and with the assent of the Education Department it may take a transfer from the School Boards of their higher grade schools. The Bill contains numerous proposals which will revolutionise the system of elementary education in this country, and greatly change the positions of Board Schools and voluntary schools.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, March.—Extreme heat in Australia in January 1896. Mr. Russell, Government Astronomer of New South Wales, writes: "We are having a very hot summer. . . . Those who hold that icebergs cool the weather will have a nut to crack with the icebergs on one hand, and these excessive heats on the other." On January 13 the temperature in the shade at Sydney rose to 108°·5. This is the greatest heat recorded there since 1859; the highest previously registered there was 106°·9 in January 1863. A temperature of 108° was also registered in Melbourne, but this temperature had been exceeded on three occasions: in January 1862, the shade temperature reached 111°·1; in 1876, 110°·7, and in the summer of 1882, 110°·5. In some inland parts of Victoria, even higher temperatures were recorded.—Severe frost in North America. Unprecedently severe weather has been experienced over the Eastern States of America, and in Newfoundland. On February 17 the thermometer registered 39° of frost at New York, a lower reading than has been recorded so late in the year since observations were begun. In the interior of the State of New York a record of 49° below zero was obtained. In Newfoundland the winter is said to be more severe than has been known for forty years. Snow was lying on the ground to a depth of fifteen feet at St. John's. At Fortune Bay the entire failure of the herring fishery has brought the people to the verge of starvation.

Wiedemann's Annalen der Physik und Chemie, No. 3.—Influence of light upon the form of discharge of an influence machine, by J. Elster and E. Geitel. The brushes and sparks from a Holtz machine passing between a kathode plate of amalgamated zinc and an anode sphere of any metal, are replaced by a glow discharge when the kathode is illuminated with short-wave light. A smaller quantity of electricity passes by this glow discharge than by the brushes and sparks in the dark.—Change of resistance due to electric radiation, by E. Aschkinass. Gratings made of strips of tinfoil have their series-resistance lowered by electric rays. The original resistance is restored by shock or heating. It is most likely that the strips are bridged by free metallic particles, but certain experiments tend to show that the process is molecular rather than purely mechanical.—Interference of electric waves, by Viktor von Lang. This was shown by an apparatus constructed on the plan of that used by Quincke for sound waves. The electric waves enter a tube which divides into two branches, and then recombines. The length of the branches can be adjusted. After recombination the waves impinge upon a Lodge "coherer" which indicates interference by changes of resistance. Well-defined maxima and minima were obtained, and the apparatus was used for obtaining the velocity of the waves in paraffin and in sulphur. The electrical index of refraction was thus found to be 1·648 for paraffin, and 2·333 for sulphur. These values are higher than those hitherto obtained.—Fluorescence of sodium and potassium vapour, by E. Wiedemann and G. C. Schmidt. The vapours of these metals show bright fluorescence when illuminated with bright sunlight. Sodium vapour shows a continuous band in the red, a fluted band in the green, and the bright sodium line in the yellow. Potassium vapour shows an intense red band. These vapours also show electro-luminescence. These results are of importance to astrophysics. The vapours in the solar atmosphere probably owe part of their luminosity to fluorescence, and this kind of radiation would not obey Kirchhoff's law.

SOCIETIES AND ACADEMIES.

London.

Royal Society, March 19.—"On the new Gas obtained from Uraninite. (Seventh Note.) Remarks on Messrs. Runge and Paschen's Diffusion Experiment." By J. Norman Lockyer, C.B., F.R.S.

I pointed out in a previous communication (*Roy. Soc. Proc.*, vol. lviii. p. 193) that, from evidence afforded by the behaviour of the lines under different conditions of the spark, the gas obtained from clèveite is in all probability compound.

Some time afterwards (July 11, 1895) Messrs. Runge and Paschen published (*Sitz. der K. Preus. Akad. der Wiss. zu Berlin*, vol. xxxiv., 1895) the same conclusion, and, as a result of a diffusion experiment (Nature, vol. lii. p. 321) described in their paper, they came to the conclusion that the gas giving the line D_3 was heavier than the gas giving the line 5015·7. As they themselves, however, pointed out, the result was not final, because the pressures were not the same. As it is important for stellar classification to settle this matter, I have recently made some experiments in which the pressures remain the same. The experiments are not yet finished, but the first, which was made on January 22, 1896, seems to leave no doubt on one point of the investigation.

An U-tube was taken, and at the bend was fixed a plaster of Paris plug about 1·5 cm. thick; in one of the limbs two platinum wires were inserted. The plug was saturated with hydrogen to free it from air; the tube was then plunged into a mercury trough, and fixed upright with the limbs full of mercury. Into the leg (A) with the platinum wires a small quantity of hydrogen was passed, and as soon after as possible another small quantity of a mixture of helium and hydrogen from samarskite was put up the other limb (B) of the U-tube.

Immediately after the helium was passed into the limb (B), spectroscopic observations were made of the gas in the limb (A); D_3 was already visible, and there was no trace of 5015·7. This result seems to clearly indicate that if a true diffusion of one constituent takes place, the component which gives D_3 is lighter than the one which gives the line at wave-length 5015·7.

Athough this result is opposed to the statement made by Runge and Paschen, it is entirely in harmony with the solar and stellar results. In support of this I may instance that of the clèveite lines associated with hydrogen in the chromosphere, and the stars of Group IIIγ, those allied to D_3 are much stronger than those belonging to the series of which 5015·7 forms part.

Physical Society, March 27.—Prof. Carey Foster, Vice-president, in the chair.—Prof. J. A. Fleming read a paper on the Edison effect. The Edison effect alluded to in the title of the paper is that if a metal plate is placed inside the loop of an incandescent lamp, then a galvanometer of which one terminal is connected to this metal plate, and the other to the positive lead of the lamp, will indicate a current passing from the lead to the plate. If, however, the galvanometer is connected to the plate and the negative lead, no current passes. Prof. Fleming, by connecting the poles of a condenser, firstly to the two leads, secondly to the plate and positive lead, and thirdly to the plate and negative lead, and in each case discharging the condenser through a galvanometer, has shown that after the lapse of a certain time, depending on the position of the plate, if the lamp is working at about four watts per candle, the potential of the plate falls to that of the negative lead. If the plate, instead of being inside the loop of the filament, is outside, then the time taken by the plate to acquire the potential of the negative lead is considerably longer. The space between the plate and the negative lead exhibits a kind of unilateral conductivity, for a battery having a low voltage is able to send a current from the plate to the negative lead, but not in the opposite direction. If instead of using a cold metal plate a second filament, maintained

in a state of incandescence by an insulated battery, is used, then a current can be obtained between this filament and both the positive and negative leads. If the voltage on the lamp is raised considerably above that required to give one candle-power for four watts, then a current can be passed from the plate to the negative lead, while a galvanometer connected to the positive lead and the plate will indicate the passage of a current from the positive lead to the plate. When the lamp is in this condition, the space between the plate and the negative lead is very sensitive to the effects of a transverse magnetic field, such a magnetic field causing a large increase in the resistance. The curve showing the connection between the current passing from the positive lead to the plate and the volts between the terminals of the lamp is found to be discontinuous. As the volts are raised the current suddenly increases about ten-fold, and it is while the lamp is in the condition corresponding to this upper portion of the curve that it is sensitive to the influence of the transverse magnetic field. By using a movable plate it has been found that the minimum current is obtained when the plate is nearer the positive than the negative lead. When an alternating current is used to supply the lamp, a continuous current can be obtained passing from the plate to either of the leads. If a small platinum cylinder is placed surrounding each of the leads, then a current can be obtained between each of the cylinders and the positive lead, but no current between the two cylinders. The largest effect occurs when a cylinder near the end of the negative lead is connected to the positive lead. The author considers that his experiments show that the resistance of a vacuum tube to the passage of a discharge would be greatly reduced if the kathode were made incandescent. Prof. S. P. Thompson said he would like to have some information as to the state of exhaustion of the lamps; whether this was such as is found in ordinary commercial lamps, or whether it more nearly approached that used by Crookes. A great change in the conductivity, &c., took place at an exhaustion slightly greater than that ordinarily found in incandescent lamps. It would be of interest to vary the size of the kathode and to investigate whether the magnitude of the effects observed depended on the fall of potential per unit length along the filament. Another point was whether the position of the plate, for which the effect was a minimum, was the same for all lamps, or whether it changed with the volts and the length of the filament employed. Again, did the minimum occur at a certain fraction of the distance between the positive and negative leads, or, as was the case in some of the phenomena observed by Crookes, at a definite distance from either of the leads. These points might be investigated by means of a lamp with a straight filament where the fall of potential per unit length along the filament might be the same as with the loop-shaped filament, but the fall of potential per unit length in the vacuum would be different. The author's proposed experiment of heating the kathode by concentrating on it the rays of a lamp, did not seem to him (Prof. Thompson) to differ materially from Crookes' experiment in which an incandescent wire, heated by a current, was used as the kathode. Mr. Skinner said that the heating of the kathode by means of a "burning-glass" could easily be carried out. Mr. Blakesley pointed out that it would be quite possible to produce an increase of the current by means of a magnet. Mr. Serle said that Prof. J. J. Thomson had shown that a magnet affected the conductivity of a gas. Prof. Fleming, in his reply, said that no doubt the effects were largely dependent on the vacuum in the lamps. The lamps employed were exhausted to the ordinary commercial vacuum. Since it was found that the "treating" was more worn off the negative leg of the filament, and that a screen placed between the legs of the filament was more blackened on the side turned towards the negative leg, it would appear that the particles of carbon were shot off from the negative leg, and hence perhaps the charge was carried by these carbon molecules.—A paper of a purely mathematical character, entitled "Notes on the electro-magnetic effect of moving charges," by Mr. W. E. Morton, was read by Mr. Serle, who also made some remarks on his own investigations dealing with this subject. The Society then adjourned till April 24.

Geological Society, March 11.—Dr. Henry Hicks, F.R.S., President, in the chair.—On an Alpine nickel-bearing serpentine with fulgurites, by Miss E. Aston, with petrographical notes by Prof. T. G. Bonney., F.R.S. The specimens described were collected on the summit of the Riffelhorn (near Zermatt) by Prof. W. Ramsay, F.R.S., and Mr. J. Eccles, and they showed some very well-marked "lightning-tubes." The rock was a serpentine, somewhat schistose from pressure, which had been formed by the alteration of a rock chiefly composed of olivine and augite. One of the analyses gave 4·92 per cent. of nickel oxide and hardly any lime. Prof. Bonney detected some awaruite under the microscope, but not nearly enough to account for the analysis. Reasons were given to show that the nickel oxide probably replaced lime in the pyroxenic constituent of the rock. The tubes, about $\frac{1}{16}$ inch in diameter, were round in section, cleanly drilled, and lined with a very thin film of dark brown or black glass.—The Pliocene glaciation, pre-glacial valleys, and lake-basins of subalpine Switzerland: with a note on the microscopic structure of Tavayanaz diabasic tufa, by Dr. C. S. Du Riche Preller. The main object of this paper, which was the sequel to one read last session, was to solve the problem whether the Pliocene glacio-fluviatile conglomerates of the Swiss lowlands were deposited on a plateau or in already existing valleys. For the purpose of this inquiry, the author examined last summer a large additional number of glacial high- and low-level deposits throughout the Zürich Valley over an area more than 40 miles in length; and his investigations further led him to important conclusions with respect to the combination of causes which determined the formation of the lake-basins lying in the same zone at the foot of the Alps. He showed that the Lake of Zürich owes its origin, in the first instance, to a zonal subsidence (probably between the first and second glaciation) of about 1000 feet, as evidenced by the reversed dip of the disturbed molasse-strata between the lakes of Zürich and Zug. During the second and third Ice-periods, the original lake-basin was gradually filled with glacial and fluviatile deposits at both ends, and was finally restricted to its present dimensions by a post-glacial bar deposited at its lower end by a tributary river. In the author's view, the other subalpine lakes, extending from the Lake of Constance to Lac Bourget in Savoy, owe their origin and present limits, in the main, to the operation of similar causes. With regard to the main question, he averred that the Lower and Middle Pliocene period was, in Switzerland, entirely one of erosion and denudation on a prodigious scale. Irrespective of the evidence he had adduced, he was therefore driven to the conclusion that at the advent of the first Ice-period in Upper Pliocene times the principal subalpine valleys must have been already excavated approximately to their present depth, and that ever since then the action of the great Alpine and subalpine rivers had been, as it is still in our own day, mainly directed to regaining the old valley-floors by removing those enormous accumulations of glacial and glacio-fluviatile material, which are respectively the direct and indirect products of three successive and general glaciations.—Notes concerning certain linear marks in a sedimentary rock, by Prof. J. E. Talmage. The marks described in the paper occur in a fine-grained argillaceous sandstone referred by the U.S. Geological Survey to the Triassic or Jura-Trias period, which is found on a low tableland within two miles of the bluffs overlooking Glen Canyon. The marks commonly appear as straight lines intersecting at right angles, but some have a pinnate distribution, suggesting engravings of frost-flowers. A description of the markings was given, and various experiments made in the laboratory to illustrate the effects of formation of crystals formed over sediment were described.

PARIS.

Academy of Sciences, March 23.—M. A. Cornu in the chair.—On the invisible radiations emitted by the salts of uranium, by M. H. Becquerel. A confirmation and extension of previous experiments upon potassium uranyl sulphate. Uranium salts appear to be unique in the length of time during which they give off photographically active rays in the dark. On comparing the rate of discharge of a gold leaf electroscope by the radiations from a crystal of potassium-uranyl sulphate and a Crookes' tube respectively, the effect of the tube was found to be over one hundred times greater than that of the crystal.—Observations on the preceding communication, by M. L. Troost.—Observations relating to a note of M. C. Henry, entitled "On the principle of an accumulator of light," by M. H. Becquerel. An account of some earlier work on the same subject overlooked by M. Henry.—Application of the X-rays to the diagnosis of surgical diseases, by M. Lannelongue. A description of the results obtained in two cases, in the second of which a supposed exostosis was shown not to exist, the pain and muscular atrophy being due to hysteria.—Researches on the earths contained in the monazite sands, by MM. P. Schützenberger and O. Boudouard.—On the quantities of nitric acid contained

in the waters of the Seine and its principal tributaries, by M. Th. Schlœsing. The amount of nitric acid reaches its minimum about August, and its maximum in February. – Study of the stability of ships by the method of small models, by M. J. Leflaive.—A new property of the surface of a wave, by A. Mannheim.—On groups of operations, by M. Levavasseur.—On a means of communicating to the X-rays the property of being deviated by the magnet, by M. A. Lafay. A bundle of rays from a Crookes' tube was allowed to imprint on a sensitive plate the shadow of a platinum wire supported on a very thin sheet of silver. When the whole was placed in a powerful magnetic field (400 C.G.S. units), the reversal of the current produced a sensible deflection of the image, if the needle was strongly electrified by being placed in connection with the negative pole of the induction coil. If the needle was not electrified, no sensible deflection of the image could be produced.—On the mechanical action proceeding from a Crookes' tube, by M. J. R. Rydberg. On repeating the experiments of MM. Gossart and Chevallier, it was found that the actions observed on the radiometer had their origin in the well-known layer of positive electricity with which the external antikathodic surface of the Crookes' tube is covered during the discharge. By covering the radiometer with a metallic gauze screen, it is possible to take Röntgen photographs through it, without any rotation or mechanical effect being observable.—Origin of the Röntgen rays, by M. Jean Perrin. From the experiments described, the conclusion is drawn that the Röntgen rays are developed only at those points where the kathode rays are arrested, and that this is true whatever material may be used for the tube.—Researches concerning the properties of the X-rays, by MM. Prince B. Galitzine and A. de Karnojitzky. By taking photographs with the rays of tourmalines superposed at various angles, results were obtained showing clearly that with crossed plates the photo-chemical action was reduced. From this the authors draw the conclusion that the X-rays correspond to transversal vibrations.—On the reduction of the time of exposure in Röntgen photographs, by M. G. Meslin. A magnet is used to create a magnetic field perpendicular to the kathode rays inside the tube. A good print of the hand was obtained after twenty-five seconds' exposure.—On the same, by M. Basilewski. A sheet of paper coated with a fluorescent substance is placed between the plate and the object. A photograph of the hand was obtained in ten minutes.—On the same, by MM. A. Imbert and H. Bertin-Sans. A magnet is used to deviate the kathode rays within the tube. Good results were obtained for the hand with exposures varying from one to five minutes.—On the X-rays, by M. Piltschikoff.—On the resistance to the passage of the Röntgen rays of some liquid and solid substances, by MM. Bleunard and Labesse. The study of the coefficients of absorption for saline solutions showed that the opacity increases with the atomic weight of both metal and non-metal.—Action of the X-rays on precious stones, by MM. A. Bugueit and A. Gascard.—Three cases of the surgical application of Röntgen photographs, by M. P. Delbet.—The Röntgen rays in the eye, by M. Wuillomenet.—On a new element contained in the rare earths, of samarium, by M. E. Demarçay. The new element is obtained by fractional crystallisation from fuming nitric acid of the portion of the rare earth rich in samarium.—Action of reducing agents upon the nitroso-compounds of ruthenium, by M. L. Brizard.—On the amalgams of molybdenum and some properties of metallic molybdenum, by M. J. Férée. Amalgams with compositions approximating to $MoHg_g$, $MoHg_2$, and Mo_2Hg_3 are described. The molybdenum obtained by distilling away the mercury from the amalgams is pyrophoric.—On the products of the distillation of wood, by M. E. Barillot.—On isomerism in the aromatic series, by M. O. de Coninck.—On rhodinol and its transformation into menthone, by MM. Ph. Barbier and L. Bouveault.—On the parasite of black-rot, by M. A. Prunet.—On the mode of formation of helicoidal coproliths, by M. Léon Vaillant —On the attribution of the genus *Vertebraria*, by M. R. Zeiller.—On vegetation in an atmosphere vitiated by respiration, by M. L. Mangin.—On two new bacteria of the potato, by M. E. Roze.—On the optical isomorphism of the felspars, by M. F. Wallerant.—On the vegetable and mineral débris of the soundings from the *Caudan*, in the Bay of Biscay, by M. Bleicher.—Oceanographical observations made during the voyage of the *Caudan*, in the Bay of Biscay, by M. J. Thoulet.—On photography through opaque bodies, by M. A. Gassend.

DIARY OF SOCIETIES.

London.

THURSDAY, April 2.

Linnean Society, at 8.—Monograph of the Genus Stemona, Lour: C. H. Wright.—On African Algæ: W. and G. S. West.
Geologists' Association (Waterloo Station), at 4.55.—Excursion to Swanage. Corfe Castle, Kimeridge, &c., ending Tuesday, April 7.
Camera Club, at 8.15.—Cloud Forms and Tropical Weather: Captain Wilson Barker.

FRIDAY, April 3.

Quekett Microscopical Club, at 8.

FRIDAY, April 10.

Royal Astronomical Society, at 8.
Geologists' Association, at 8.
Malacological Society at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Text-Book of Comparative Anatomy: Dr. A. Lang, translated by H. M. and M. Bernard, Part 2 (Macmillan).—Royal University of Ireland, Calendar for 1896 (Dublin, Thom).—Reduction of Greenwich Meteorological Observations. Part 3. Temperature 1841-1890 (London).—Report of the Commissioner of Education for the Year 1892-93, Vol. 1 (Washington).—Outlines of Logic and Metaphysics: J. E. Erdmann, translated by Dr. B. C. Burt (Sonnenschein).—Méthode et Principes des Sciences Naturelles. Introduction a l'Etude de la Médecine: Th. Funck-Brentano (Paris, Bataille).—The Astronomy of Milton's "Paradise Lost": Dr. T. N. Orchard (Longmans).—The Principles of Sociology: Prof. T. H. Giddings (Macmillan).—Our Country's Butterflies and Moths: W. J. Gordon (Day).—Société d'Encouragement pour l'Industrie Nationale, Annuaire pour l'Année 1896 (Paris).—Le Climat de la Belgique en 1895: A. Lancaster (Bruxelles).—Die Protrophie: A. Minks (Berlin, Friedländer).—Physiological Papers: Prof. H. N. Martin (Baltimore, Johns Hopkins Press).

Pamphlets.—Kosto Komparatibo en Chile del Gas i de la Eliktrizidad, &c.: A. E. Salazar i K. Newman (Santiago).—Energetik und Hygiene des Nerven-systems in der Schule: Dr. H. Griesbach (München, Oldenbourg).—Metric System of Weights and Measures: G. T. P. Streeter (Gee).—Philip's Special Map of the Nile Valley, &c. (Philip).—Philip's Special Large Scale War Map of the Soudan (Philip).

Serials.—Sunday Magazine, April (Isbister).—Good Words, April (Isbister).—Longman's Magazine, April (Longmans).—Chambers's Journal, (Chambers)—Natural Science, April (Rait).—Bulletin of the American Mathematical Society, March (Macmillan).—Humanitarian, April (Hutchinson).—History of Mankind: F. Ratzel, translated, Part 7 (Macmillan).—Journal of the Royal Horticultural Society, March (Victoria Street).—Proceedings of the American Philosophical Society, July (Philadelphia).—Century Magazine, April (Macmillan).—National Review, April (Arnold).—Mémoires de la Section Caucasienne de la Société Impériale Russe de Géographie, livre xvii. livr^{n} 1.—Ditto, livre xviii.—Jahrbuch der Meteorologischen Beobachtungen der Wetterwarte der Magdeburgischen Zeitung, Band xiii., 1894 (Magdeburg).—Contemporary Review, April (Isbister).

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